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The Zooplankton of the Little Manatee River Estuary, Florida.
First Yearly Report: 1988

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Department of Marine Science, University of South Florida

Funding for this project was provided by the Florida Department of Environmental Regulation, Office of Coastal Management using funds made available through the National Oceanic and Atmospheric Administration under the Coastal Zone Management Act of 1972, as ammended. Local administration of this work was conducted through contracts with the Southwest Florida Water Management District; project manager, Michael S. Flannery.

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EXECUTIVE SUMMARY

Zooplankton were collected bi-weekly from the Little Manatee River Estuary for a period of one year from January 1988 through January 1989. Six stations were sampled: a control placed approximately 2 miles out of the mouth of the river into the bay, and five stations spaced at roughly 2-mile intervals within the river beginning at the mouth. Collections were made at night during incoming tides. At each station, samples of 44 liters were taken by evenly spacing four 11 liter niskin bottle casts throughout the water column. The water was then passed through a 0.028 mm sieve in order to capture all multicellular animals present. Abundances for each organism identified were calculated as number per cubic meter. Dominant organisms were placed into size categories which were used to estimate biomass from previously calculated length-weight regressions. Salinity, temperature and dissolved oxygen were also measured at each station.

Sixty-seven groups of zooplankton were identified. Dominants (those groups making up more than 1% of total abundance at any station) included copepod crustaceans, polychaete worm larvae, rotifers, mollusk larvae and crab larvae. The diversity and abundance of the zooplankton in the bay were greater than in the fresh and brackish water regions of the river. Average abundance and biomass within the river was 143,000/m^3 and 46.9 mg/m^3 compared to bay values of 351,000/m^3 and 175 mg/m^3. As a result, the abundance of zooplankton in the river tended to be positively correlated with salinity and was low during periods of high rainfall when the bay water was excluded from the river. A number of freshwater crustaceans and rotifers were found at the upper stations during periods of high flow, however, their abundance was usually low in comparison to the higher salinity fauna. The larvae of copepod crustaceans were the most abundant plankter at all stations and often contributed the greatest biomass. The small mesh used (about one half the size of the smallest size usually used in this type of study) demonstrates a much higher contribution from these small plankters than usually reported. The zooplankton of the bay included a higher percentage contribution from the larvae of benthic invertebrates (6.31%) than that of the river (3.90%), as is expected from the greater number of benthic invertebrates found there.

A number of studies have demonstrated that most of the dominant species found in this survey serve as food for larval and juvenile fish. Larval fish abundance, however, showed little relationship to zooplankton abundance so other fish food items must be important, particularly in low salinity areas. Since fish larvae were collected simultaneously with zooplankton, planned work on the gut contents of these fish will serve to clarify the relative importance of zooplankton in supporting fish production in the Little Manatee River.

The Zooplankton of the Little Manatee River Estuary, Florida.

Objectives

The Little Manatee River zooplankton survey is part of an ongoing multidisciplinary study which addresses physical and chemical parameters, and the distribution of phytoplankton, ichthyoplankton, and juvenile and adult fish within the river. Since the Little Manatee river is, as yet, only moderately encroached upon by man, a study of this area may serve both as a comparison for the more impacted tributaries of Tampa Bay, and as background information for subsequent research as the watershed is further developed. Zooplankton and ichthyoplankton were sampled simultaneously so that the trophic relationship between the two groups could be addressed.

Related Studies

Although the distribution of zooplankton species on the west coast of Florida has been addressed by a number of authors, most studies are either lacking in seasonal data or deal with areas of higher salinities than those measured in the Little Manatee River. Davis (1950) gives a good general account of species composition in Florida waters, but gives no seasonal information and mainly deals with areas of higher salinity than those found in the Little Manatee River. King (1950) presents taxonomic data on a variety of locations along the Florida west coast. Two of his stations are similar to the Little Manatee River in salinity structure and fresh water flow conditions (the Caloosahatchie River near Fort Myers and the Peace River near Punta Gorda), but no seasonal information is given. Grice (1956) reports on the seasonality of Copepoda observed in weekly samples taken at Alligator Harbor, but salinities there (26-31 ppt.) were much higher than those seen in the Little Manatee River. Davis and Williams (1958) present an informative account of species distribution in mangrove areas in southern Florida. Salinity regimes in the areas studied are similar to those found in the Little Manatee River, but seasonal information is lacking. Hopkins (1966) gives a comprehensive treatment of the zooplankton of the St. Andrew Bay system, but in contrast to the Little Manatee River, this area tends to be more saline with much advection of truly marine species from the Gulf. It is therefore difficult to make comparisons. Studies that lend themselves to comparison include Hopkins (1977), Weiss (1978) and Squires (1984). Hopkins (1977) presents seasonal information on zooplankton of Tampa Bay, however, resolution is limited as samples were taken quarterly. Although stations were sampled within the Little Manatee River, these results were not published. Weiss (1978) and Squires (1984) present data that is similar to the present study from the Anclote estuary and Charlotte Harbor, respectively.

The Little Manatee River

Lewis and Estevez (1988) give a good general account of the ecology of Tampa Bay and include the following information about the River. The Little Manatee River is located on the eastern shore of Tampa Bay at latitude 27°40' N and longitude 82° 30' W, draining an area of approximately 211 square miles in Hillsborough and Manatee counties. Discharge, averaged over the year, is estimated to be near 235 cubic feet per second, making it the smallest of Tampa Bay's four major tributaries. Tidal influence extends 15 miles (24km) upriver. The Little Manatee River is considered the least impacted of Tampa Bay's rivers, with only 2.7% of its watershed urbanized. It also has the lowest phosphorous and organic nitrogen concentrations and carries the least amount of oxygen demanding material. The Little Manatee River is thus well suited for a background study of zooplankton distribution and seasonality in a tributary to Tampa Bay.

METHODS

Station placement and sampling times coincided with those of the ichthyoplankton survey. Six stations were sampled semimonthly from January 1988 through January 1989. Five of the stations were distributed within the Little Manatee River at roughly two mile intervals beginning with station 1 approximately one mile upriver from the I-75 overpass and ending at the river mouth with station 5 (see map, Fig 1a). River mile designations for stations 1 through five are as follows: 1, 8.8; 2, 6.4; 3, 4.4; 4, 2.2; 5, 0.0. A sixth station which served as a control was placed 2.2 miles into Tampa bay, outside of the river's direct influence except during periods of very high flow. Samples were taken at night, usually between the hours of 7:00pm and 1:00am, on an incoming tide. Stations were divided into upper and lower river sets of three and sampled on two successive nights in order to remain in phase with the tides. Water was collected with an 11 liter Niskin bottle. At each station four 44 liter samples were taken: two samples integrating the water column, one surface and one bottom sample. During the first five collections, reduced volumes of 33 liter and on rare occasions 22 liters were sieved at times when clogging made sieving greater volumes impossible. Integrated samples were taken by evenly spacing four bottle casts between the surface and approximately 20 cm above the sediment. Two replicate integrated samples were taken at each station approximately 500m apart, one at each end of the ichtyoplankton tow area. Surface samples were taken from the upper meter of the water column, and bottom samples within the one meter zone standing 20 cm over the bottom. Samples were placed in a holding vessel and sieved through a Nitex mesh. Sieves were used in place of plankton nets in order to avoid problems of quantification resulting from the clogging of small mesh nets. In collections one through five an 11 um mesh was used. As this was prone to clogging, however, mesh size was increased to 28 um in subsequent collections. Sieving experiments from the larger to smaller mesh showed that there was no significant loss of metazoans from the 28 um fraction. Samples were preserved immediately upon collection in 3-5 percent formalin buffered with sodium borate.

Temperature, salinity and dissolved oxygen were also measured at each station. Readings were taken at 0.5 meter intervals from surface to bottom.

Zooplankton samples were split in a Motoda box (Motoda 1959) until an aliquot containing approximately 1500 individuals was obtained. Samples were then placed in ruled petri dishes. Smaller plankters (<0.3mm) were counted at 50X, and larger ones at 25X. At least 100 specimens of each dominant taxon were counted. In cases where it was not necessary to count the entire tray, diagonals were counted to avoid bias resulting from clumping generated by currents within the tray. Most holoplanktonic animals were identified to species. Meroplankton (those plankters found in the water column for only a portion of their lifecycle), tychoplankton (benthic animals swept off the bottom by currents). and hypoplankton (benthic animals which swim off the bottom only for a limited period of time) were identified only to major group.

For each sample analyzed, twenty-five individuals from each taxon were measured and placed into one of three group specific size classes (two size classes were used for species with low size variation). Size class data were then used to estimate biomass from length:weight regressions presented in Weiss (1978). These regressions were either empirically determined by weighing a number of organisms of a specific size class on microscope coverslips, taken from those determined for similar organisms, or estimated from geometric volume calculations.

Zooplankton densities were often compared with salinity distribution. To test for correlations a nonparametric Spearman's coefficient of rank correlation (r_s) was used, as density distributions did not lend themselves to parametric statistics.

SOURCES OF BIAS

Bias in the data can be divided into two categories: that from the sampling procedure and timing (field procedure), and that introduced in the process of sample splitting and counting (laboratory procedures). Discussion of the latter is found in Weiss (1978). Briefly, variability of counting was found to be independent of taxon and to depend solely on density within the sample. A curve of coefficient of variation among replicate countings plotted against number of zooplankters counted, shows that variation for dominant zooplankters (about 50-100 individuals counted per sample) fell in to the 20-30% range while those for total zooplankton counted (500-1000 individuals) were close to 10%.

Variation over the diel and tidal cycle was not investigated as all sampling was done at similar times and tidal conditions. Weiss (1978) sampled over an entire tidal cycle at two times during the year and found the coefficient of variation of the dominant holoplanktonic and meroplanktonic species in single samples to average 37% in September when abundances were high and 61% in December at lower overall abundances. These numbers, however, also reflect variation resulting from day/night migrations and watermass movements. Minello et al. (1981) in a study of diel zooplankton variation in a northwestern Gulf of Mexico estuary, found counting and subsampling error to be insignificant when compared to replicate tow variability, and this in turn insignificant compared to variability over the diel cycle. Although tidal and light cycles could not be separated in this study, it was suspected that diel vertical migration contributed greatly to variation. Diel vertical variation in abundance of species which were dominant in the Little Manatee river was seen by Fulton (1984) in estuaries near Beaufort, North Carolina. _Acartia tonsa_, _Parvocalanus crassirostris_ and _Pseudodiaptomus coronatus_ tended to remain on or towards the bottom during the day. This should not present a problem in the present study, however, as these species were more uniformly distributed throughout the water column at night. Fulton found copepod nauplii and _Oithona_ spp. were uniformly distributed at all times. Omori and Hamner (1982), however, have observed swarming in Oithona, Acartia and Labidocera in association with grassbeds, coral heads and shallow embayments.

Although horizontal variability cannot be separated from error inherent in the sampling procedure itself, as only two replicates were taken, the upper end of this variation can be bracketed as less than or equal to variation between replicates. Replicate samples were taken approximately 250m apart. Mean coefficients of variation (essentially range/ mean in a two sample situation) for the each replicate set (n=144) was determined for four representative groups of taxa: copepod nauplii (44.86%), polychaete larvae (75.28%), adult and copepodid *Acartia tonsa* (56.96%), and total zooplankton counts (73%). Coefficients of variation between replicates were inversely proportional to relative abundance for the more specific groups observed (i.e., excluding total zooplankton).

Bias in sampling procedure also includes that introduced by mesh size and water volume sampled. As a 28 um sieve was used minimal loss of smaller metazoans is expected. Relative to most previous zooplankton studies using 64-74 um mesh, however, a significant increase in the proportion of microzooplankton captured is probable. Hopkins (1977) found that a 64 um sieve retains 69% of the metazoans caught on a 28 um mesh. Most loss consisted of copepod nauplii and pelecypod larvae. Due to the small size of the zooplankton that passed through the 64 um sieve, only 6% of the biomass was lost. Precision of density determinations of plankters on the upper end of the size scale was often limited by their low numbers. As larger zooplankters are usually found at low densities, accurate estimations of abundance from counts made on a 44 liter samples, to the degree that this was possible for the smaller, more abundant zooplankters, could not be made.

Table 1. Sampling Dates.

Coll. No./	Dates	Coll. No./	Date	Coll. No./	Dates
1.	1/29-30/88	9.	5/25-26/88	17.	9/ 26-27/88
2.	2/10-11/88	10.	6/ 8-9 /88	18.	10/11-12/88
3.	2/23-24/88	11.	6/27-28/88	19.	10/25-26/88
4.	3/ 3-4 /88	12.	7/11-12/88	20.	11/14-15/88
5.	3/23-24/88	13.	7/25-26/88	21.	11/28-29/88
6.	4/ 6-7 /88	14.	8/ 9-10/88	22.	12/13-14/88
7.	4/25-26/88	15.	8/24-25/88	23.	12/26-27/88
8.	5/11-12/88	16.	9/12-13/88	24.	1/ 16-17/88

RESULTS AND DISCUSSION

Hydrographic Data

All temperature, salinity and dissolved oxygen readings are given as water column averages. Water temperature (Fig. 2) in the Little Manatee River ranged from a low in January at collection 1 of 12.8°C to a high of 32.0°C in August. Greatest temperature variation among stations was seen in the months of July and August, but differences never exceeded 3°C during any given collection. Temperatures recorded at the river stations tended to be cooler than those of the bay.

Salinity rarely varied greatly throughout the water column as depths within the river usually did not exceed 2 m and vertical mixing was significant. Salinity in the river (Fig. 1) ranged from a low of 0 ppt that was often seen at stations 1-3 and on two occasions at station 4, to a high of 30 ppt at the river mouth during collection 10 in June. Maximum salinity at station 6 in Tampa Bay was 33.5 ppt during collection 14 in August. Maximum salinity range from station 1 to the river mouth was 0.4 ppt to 24.0 ppt during collection 1 in January. Two major drops in salinity were observed, one beginning from a high at collection 1 and dropping to a low throughout February and March, and a second beginning towards the end of July and dropping to a low at extending from July through September.

Dissolved oxygen (Fig. 3) ranged from a low of 2.3 ppm at station 1 in July to a high of 11 ppm at the same station in October. More typical highs ranged up to about 9 ppm, however. Readings were generally below 4 ppm from July through September. Dissolved oxygen at the bay station followed the general trend seen in the river yet remained more stable. Dissolved oxygen showed a strong negative correlation with temperature (r_s=-0.8038, $p<0.001$).

Flow rates in the Little Manatee River (Fig. 4) varied from a low of approximately 15 cf/s in June to a peak of 9720 cf/s after four days of unusually heavy rainfall in September. Flow was at increased levels during the period from July to the end of August. Other high flow levels were seen in February, early March, and after tropical storm Keith in November. Periods of low flow occurred from November to January and most notably during the period of drought from April through June.

ZOOPLANKTON

Zooplankton taxa were classified in 67 categories (Table 2). In most cases, holoplankton were identified to species. Exceptions include freshwater copepods in the family Cyclopidae, Calanoids in the genus Diaptomus and rotifers. In all, 29 groups of holoplankton were identified. Meroplankton and tychoplankton/ hypoplankton were identified only to major group (e.g., crab zoea, pelecypod larvae, etc.). Meroplankton and tychoplankton/ hypoplankton were placed in 26 and 12 groups, respectively.

Abundance rankings for zooplankton taxonomic groups were created excluding station 6 which was used as a control to compare the fauna of the river to that of Tampa Bay (Table 3). A breakdown of dominants for each of the five river stations is given in Table 4. Taxonomic groupings were arbitrarily placed into three classes according to their average contribution to overall abundance within the river. Plankters making up more than 1.0% by number were classified as dominants, those contributing between 1.0% and 0.1% were considered subdominants, and those constituting less than 0.1% of total numbers are classed as uncommon. Six taxonomic categories are included under the classification of dominant: copepod nauplii (81.5%), Oithona colcarva (6.0%), Acartia tonsa (3.9%), benthic harpacticoid copepods (1.8%), polychaete larvae (1.7%) and rotifers (1.1%). O. colcarva, A. tonsa and benthic harpacticoids undoubtedly contributed greatly to copepod nauplii numbers, but, as nauplii were not identified to species, their relative contributions cannot be quantified. Taken together these dominant make up approximately 96.0% of total plankton numbers and 86.4% of the calculated biomass within the river.

Subdominants include nine groupings contributing 2.93% of total density and 7.89% of total biomass in the river. Eurytemora hirundoides, Pseudodiaptomus coronatus, and Oikiopleura dioica, although not large contributors in terms of numbers, ranked fifth, sixth and seventh in biomass contributions because of their relatively large size.

Table 3. Relative contributions to total abundance and biomass at stations within the Little Manatee river (stations 1-5); numbers in parentheses are from station 6, within Tampa Bay.

Category	Species/ Group	% Abundance	% Biomass
Dominant	Copepod nauplii	81.5 (53.9)	28.7 (9.1)
	Oithona colcarva	6.0 (21.5)	11.4 (28.6)
	Acartia tonsa	3.9 (3.9)	31.4 (25.2)
	Benthic Harpacticoids	1.8 (0.2)	14.0 (1.9)
	Polychaete Larvae	1.7 (7.4)	0.88 (4.7)
	Rotifera	1.1 (0.1)	0.08 (0.01)
Subdominants	Pelecypod Larvae	0.95 (2.1)	0.25 (0.64)
	Barnacle nauplii	0.52 (0.76)	0.10 (0.14)
	Eurytemora hirundoides	0.36 (0.00)	1.58 (0.01)
	Pseudodiaptomus coronatus	0.31 (0.89)	2.58 (3.8)
	Oikiopleura dioica	0.21 (1.1)	1.63 (3.9)
	Parvocalanus crassirostris	0.18 (3.4)	0.34 (4.2)
	Gastropod Larvae	0.17 (0.47)	0.29 (0.57)
	Euterpina acutifrons	0.13 (0.85)	0.90 (5.1)
	Saphirella spp.	0.10 (0.45)	0.22 (0.63)

Table 4. Abundance and biomass of dominants by station averaged over the year. Taxa with asterisks formed >1% of biomass, but did not fall into the dominant category in terms of abundance at that station.

Taxonomic Group	Abundance (perc.) Number/m^3	Biomass (perc.) mg DW/m^3
STATION 1 (Mile 8.8)		
Copepod nauplii	23600 (72.2%)	2.83 (29.1%)
Rotifera	4310 (13.2%)	0.10 (1.04%)
Eurytemora hirundoides	1480 (4.53%)	2.58 (26.3%)
Benthic Harpacticoida	1240 (3.80%)	3.02 (30.7%)
Pelecypod larvae	596 (1.82%)	0.027(0.28%)
Polychaete larvae	522 (1.60%)	0.106(1.09%)
Decapod zoea*	16.5(0.05%)	0.230(2.40%)

Table 4. (cont.)

STATION 2 (Mile 6.4)

Copepod nauplii	77000 (82.8%)	9.33 (29.7%)
Benthic Harpacticoida	4060 (4.36%)	12.6 (40.1%)
Rotifera	2980 (3.20%)	0.07 (0.22%)
Acartia tonsa	2820 (3.03%)	4.58 (14.6%)
Polychaete larvae	1900 (2.04%)	0.29 (0.93%)
Pelecypod larvae	1250 (1.35%)	0.09 (0.29%)
Decapod zoea*	57.6 (0.06%)	2.63 (8.37%)

STATION 3 (Mile 4.4)

Copepod nauplii	141000 (88.5%)	18.8 (39.8%)
Acartia tonsa	5460 (3.43%)	13.6 (28.9%)
Benthic Harpacticoida	5400 (3.42%)	11.2 (23.7%)
Oithona colcarva	2310 (1.45%)	1.39 (2.94%)
Polychaete larvae	1880 (1.18%)	0.26 (0.56%)
Decapod zoea*	56.7 (0.04%)	1.10 (2.34%)

STATION 4 (mile 2.2)

Copepod nauplii	158000 (87.8%)	17.2 (35.8%)
Acartia tonsa	8030 (5.45%)	20.1 (41.7%)
Oithona colcarva	6710 (3.72%)	3.73 (7.73%)
Polychaete larvae	2970 (1.65%)	0.39 (0.81%)
Benthic Harpacticoida*	1090 (0.61%)	2.48 (5.15%)
_Oikiopleura dioica_*	457 (0.25%)	0.66 (1.38%)
Decapod zoea*	97.8(0.05%)	1.25 (2.59%)

STATION 5 (River Mouth)

Copepod nauplii	182000 (73.2%)	19.0 (19.5%)
Oithona colcarva	33100 (13.3%)	21.3 (21.9%)
Acartia tonsa	11700 (4.71%)	35.1 (36.0%)
Polychaete larvae	4660 (1.88%)	1.02 (1.05%)
Pelecypod larvae	3800 (1.53%)	0.34 (0.35%)
_Pseudodiaptomus coronatus_*	2010 (0.81%)	5.64 (5.80%)
_Oikiopleura dioica_*	1050 (0.42%)	3.16 (3.24%)
Benthic Harpacticoida*	889 (0.36%)	3.37 (3.46%)
_Euterpina acutifrons_*	780 (0.31%)	1.74 (1.79%)
Decapod zoea*	276 (0.11%)	1.97 (2.02%)

Table 4. (cont.)

STATION 6 (Bay)

Copepod nauplii	189000 (53.9%)	16.0 (9.12%)
Oithona colcarva	75600 (21.5%)	50.0 (28.6%)
Polychaete larvae	26100 (7.43%)	8.34 (4.76%)
Acartia tonsa	14000 (3.98%)	44.1 (25.2%)
Parvocalanus crassirostris	12000 (3.43%)	7.52 (4.29%)
Pelecypod larvae	7580 (2.16%)	1.13 (0.64%)
Oikiopleura dioica	4070 (1.16%)	6.83 (3.90%)
*Pseudodiaptomus coronatus**	3110 (0.89%)	6.74 (3.85%)
*Euterpina acutifrons**	2980 (0.85%)	9.08 (5.18%)
Benthic Harpacticoida*	909 (0.26%)	3.35 (1.92%)
Decapod zoea*	675 (0.19%)	6.10 (3.48%)
Barnacle cyprids*	436 (0.12%)	2.35 (1.35%)
*Sagitta tenuis**	254 (0.07%)	2.10 (1.20%)

Dominant Zooplankters

1. Copepod nauplii. (Fig. 5) Numerically, copepod nauplii were by far the most abundant zooplankton and were second only to *Acartia tonsa* in biomass. Proportionally, nauplii were of greater importance within the river (81%) than at the Bay station (53%). In terms of absolute numbers, however, nauplii were on average more abundant at the Tampa Bay station: 189,000/m^3 vs. 116,000/m^3 in the river stations. Naupliar abundance was found to be considerably higher in this study than that seen by Hopkins (1977; a mean of 26,644/m^3 for the Mid Tampa Bay area). In regards to biomass contribution, these two studies are also disparate: 2.36 mg/m^3 in Hopkins (1977) vs. 15.98 mg/m^3. As Hopkins used a 74 um mesh, a number of smaller nauplii were probably lost that were captured in the 28 um mesh used in the present study. In a study of the Anclote estuary by Weiss (1978) using 64 um mesh, naupliar abundances, although still less than those found at the bay station, are comparable to those seen in the present study (between 97370-131014/m^3 at stations of similar salinities). Biomass ranged from 6.18-6.63 mg/m^3, much less than the 15.98 mg/m^3 calculated at station 6. Squires (1984), in a study of the Charlotte harbor area using 70um mesh, found copepod nauplii densities at station 2 (the station most similar in salinity structure to the Tampa Bay station in the present study) of 127,741/m^3 with a biomass of 12.17 mg/m^3. None of the above mentioned studies included stations that were comparable to the river stations as salinity fluctuations within the river were much greater than those seen in the Tampa Bay, Anclote estuary or Charlotte Harbor. Nauplii abundance was positively correlated to salinity in the river (r_s=0.6854, $p<0.001$). This is expected as much of the copepod density within the river was the result of importation from the high salinity, high abundance waters of the bay.

Copepod nauplii abundance seemed to be inversely related to flow within the river. This was, no doubt, both the result of dilution at high flow rates and exclusion of the high density bay waters from the river. At any one time, naupliar abundance was usually lower in the upriver stations, probably the result of the lower overall copepod abundances there.

2. Oithona colcarva. (Fig. 6) In terms of biomass, the cyclopoid copepod O. colcarva is ranked fourth within the river and first at the Bay station, contributing 11.38% (5.3 mg/m^3) and 28.55% (50.0 mg/m^3) on average, respectively. Numerically, this cyclopoid ranked second within both the river and the bay contributing on average 5.96% (8500/m^3) and 21.54% (75,600/m^3). Hopkins (1977) found a density of 11,496/m^3 for O. colcarva at the Mid Bay station and a whole bay average biomass of 7.92 mg/m^3. Weiss (1978) found a density range of 13,117-16,474/m^3 and a biomass range of 5.02-7.15 mg/m^3 in the Anclote estuary. In Charlotte Harbor Squires (1984) found densities more similar to those at station 6 in the present study: 56,669/m^3 and 30.64 mg/m^3. O. colcarva density was positively correlated with salinity (r_s=0.8532, $p<0.001$).

Oithona colcarva is a bay species that is only found within the river during periods of low flow and high salinity. Abundances were low at the upper stations. In eight of the collections, O. colcarva was absent from all three upper stations and in only one collection was it found at station 1.

3. Acartia tonsa. (Fig. 7) Within the Little Manatee River, the calanoid copepod A. tonsa contributed 3.93% of the zooplankters by number, ranking it third, and 31.4% of the biomass, ranking it first. In absolute terms, A. tonsa averaged 5613/m^3 and 14.72 mg/m^3 within the river. At the bay station averages were 13,900/m^3 (4.0%) and 44.12 mg/m^3 (25.18%). As with other taxa, abundance values for A. tonsa found by Hopkins (1977) in the middle Tampa Bay region (2278/m^3) were much lower than those seen at the bay station. Hopkins did note, however, that densities at the mouth of the Manatee River were much higher, indicating the possibility that the bay station in the present study was not entirely out of the influence of the river. Weiss (1978), at a station in the Anclote River system of similar salinity structure to our bay station, found comparable densities (13,400/m^3; 22.57 mg/m^3). In Charlotte Harbor, Squires (1984) also found similar densities (8,069/m^3; 26.27 mg/m^3). A. tonsa density was positively correlated with salinity (r_s=0.6656, $p<0.001$).

Acartia tonsa exhibited a similar distributional pattern to that of Oithona colcarva, yet was found at lower salinities and was therefore at greater abundances at the upper river stations and during periods of high flow.

4. Benthic Harpacticoid Copepods. (Fig. 8) Harpacticoid copepods, excluding Euterpina acutifrons and Miracia sp. which are holoplanktonic, ranked fourth in both relative density (1.78%) and biomass (14.0%) within the river (2552/m^3; 6.55 mg/m^3). At the bay station densities were much lower: 931/m^3 (0.26%), 3.39 mg/m^3 (1.9%). Because harpacticoids are important mainly within the river at lower salinities, comparisons to Charlotte Harbor and the Anclote estuary cannot be made as hydrographically similar areas were not investigated in these studies. Comparisons of the bay station to stations of similar salinity showed that in the Anclote estuary numbers and biomass were similar, but were lower in Charlotte Harbor. No significant correlation was found between density and salinity, due at least in part to the fact that this category is made up of a group of species having differing salinity tolerances.

This group exhibited relatively stable densities throughout the year, especially at the lower stations. The upper stations were more variable than the lower, probably a result of the increased influence of freshwater flow variation there. In all, this group was less affected by flow within the river than the previous three dominants, probably as a result of their benthic nature and consequent partial independence from the water column.

5. Polychaete Larvae. (Fig. 10) Polychaetes were the most numerous component of the meroplankton, and ranked fifth and tenth, respectively, in terms of density (2386/m^3; 1.7%) and biomass (0.42 mg/m^3; 0.88%) in the river. At station 6 in the bay numbers were much higher (26,100/m^3; 8.34 mg/m^3). These numbers are much higher than those found in Tampa Bay by Hopkins (1977) and in the Anclote estuary by Weiss (1978), but are close to those seen in Charlotte Harbor (18,809/m^3) by Squires (1984). Polychaete numbers were positively correlated with salinity (r_s=0.7445, $p<0.001$).

Polychaete larvae, being essentially marine also tended to drop in abundance both at times of high flow and at the upriver stations. A decrease in abundance at successive upriver stations was not as clear as that demonstrated by a true bay species (e.g., Oithona colcarva) indicating some degree of production within the river.

6. Rotifera. (Fig. 9) Although of little importance in terms of biomass, rotifers were at times numerically significant, especially at the upriver stations. Average density and biomass were 1637/m^3 and 0.04 mg/m^3 within the river. Rotifers were not identified but common genera included Trichocerca, Proales and Keratella at stations with higher salinities. Brachionus, Lecane, Monostyla and Platyias were common at lower salinity stations within the river.

Rotifer abundance increased and became more stable moving from the bay station to station 1. Abundances tended to decrease with increasing flow probably as the result of dilution. This group, like the polychaete larvae and the benthic harpacticoids, consists of a number of species of greatly differing salinity tolerances, thus obscuring patterns of distribution evident in monospecific analyses.

Subdominant Zooplankters

Nine categories of zooplankton contributed between 0.1% and 1.0% to total abundance within the river and were thus classed as subdominants. Five of these, Pseudodiaptomus coronatus, Oikiopleura dioica, Parvocalanus crassirostris, Euterpina acutifrons and Saphirella spp., were members of the higher salinity bay fauna that entered the river in diluted densities during periods of low flow.

Pseudodiaptomus coronatus (Fig. 11) was found in salinities ranging from 18 to 34 ppt. This is a relatively large species and, although it contributed relatively little in term of numbers (448/m^3, 0.31%), it ranked fifth in contribution to biomass within the river (1.21 mg/m^3, 2.58%). Considerably higher abundance and biomass was seen at the bay station (3110/m^3, 6.73 mg/m^3). Much lower abundances were seen in Hopkins (1977) study of Tampa Bay, Charlotte Harbor (Squires 1984) and the Anclote estuary (Weiss 1978). This is probably in part due to the epibenthic nature of this species during the day (Jacobs 1968), as the above studies involved daytime surface collections.

Parvocalanus crassirostris (Fig. 12) was an abundant copepod within the bay contributing 3.4% (12,000/m^3) of the abundance at the bay station, making it the third most abundant copepod there. Within the river, however, it was of less importance as it was rarely found at salinities lower than 18 ppt. Densities within the river averaged 263/m^3 and biomass 0.16 mg/m^3.

Euterpina acutifrons (Fig. 13), was also relatively abundant within the bay, but was rare within the river and rare at salinities lower than 15 ppt. Average abundance and biomass within the river were 190/m^3 and 2.1 mg/m^3.

Oikiopleura dioica (Fig. 14) was present mainly in salinities higher than 18 ppt. At station 6, this species averaged 4070/m^3 and 6.8 mg/m^3. Within the river averages were 301/m^3 and 0.76 mg/m^3. No larvaceans were found upriver from station 4. These numbers are similar to those found by Hopkins in Tampa Bay and Weiss in the Anclote Estuary, but were much lower than those seen by Squires in Charlotte Harbor.

Saphirella spp. (Fig. 15) abundance was positively correlated to salinity (r_s=0.6610, $p<0.001$) and although it was found at all stations, its numbers were sharply reduced at lower salinities. At least two species were collected. Abundance and biomass within the river and the bay averaged 146/m^3 (0.10 mg/m^3) and 1580/m^3 (1.10 mg/m^3), respectively.

Eurytemora hirundoides (Fig. 16) is a brackish water copepod that was often very abundant at upper river stations, mainly between salinities of 1-10 ppt. This species made a significant contribution to biomass (0.74 mg/m^3, 1.58%) within the river and often dominated samples taken at the upper stations. The nauplii of E. hirundoides are large and were at times abundant at stations 1-3. This was the only calanoid copepod that was present in significant numbers at low salinities.

Pelecypod and gastropod veligers were at times abundant within the river and often showed trends related to freshwater flow regimes. Pelecypod larvae (Fig. 17) were especially abundant at times of higher salinity and showed a pattern of abundance from station to station indicative of import from the higher salinities of the bay. Gastropod veligers (Fig. 18) demonstrated a similar trend, although, somewhat less clearly. Average densities and biomasses for the river stations were, for bivalves, 1350/m^3 (0.11 mg/m^3) and for gastropods, 249/m^3 (0.13 mg/m^3).

Barnacle nauplii (Fig. 19) within the river averaged 744/m^3 and 0.05 mg/m^3, about an order of magnitude lower than densities at the bay station. At the upper stations, density patterns are related to salinity trends (i.e., present at times of higher salinity) indicating importation from the higher salinity lower stations. Densities at the lower river stations, however, show a patchy distribution indicative of some degree of localized production.

Uncommon Zooplankters

At times, species not considered dominant or subdominant were found at significant densities. Most notable among these were the cladocerans Evadne tergestina, Podon polyphemoides and Penilia avirostris. In 24 of the 288 samples taken one of these species was found at densities in excess of 1000/m^3. These cladocera are essentially bay species that were important within the river only at periods of high salinity.

Other uncommon zooplankters occasionally found at high densities include amphipods, decapod zoea, and polyclad flatworms. Stations where these plankters occurred and time of year are listed in Table 5.

TOTAL ZOOPLANKTON

The abundance and biomass yearly averages for each category of zooplankton at each station are given in Table 6. Total zooplankton density and biomass averaged throughout the year within the river were $143,000/m^3$ and $46.9\ mg/m^3$. These were considerably lower than the average density and biomass seen at the Tampa Bay station of $351,000/m^3$ and $175\ mg/m^3$. Broken down into plankton type, numerically the catch averaged for the five river stations was 94.0% holoplankton, 3.90% meroplankton and 2.10% tycho/hypoplankton. Biomass percentages were 79.6%, 6.31% and 14.1%, respectively. Bay station densities were 87.7% holoplankton, 11.8% meroplankton and 0.44% Tycho/hypoplankton. Biomass ratios for these plankton categories in the bay were 85.0%, 12.9% and 2.10%, respectively. Thus, the bay had higher numbers of meroplanktonic organisms as would be expected from the higher diversity of the benthic invertebrate fauna found there. The river's higher percentage of tychoplankton is probably the result of scouring during periods of high flow. Tychoplankton peaks at stations 1 and 2 during May and at station 3 during July represent high abundances of benthic harpacticoid copepods.

Total zooplankton seasonal fluctuations in both density and biomass are shown in Fig. 20. From a seasonal perspective, total zooplankton biomass at the bay station was at a low at collection 2 in February and peaked at collection 9 in May. The river stations generally reflected this pattern with modification during periods of high flow. For example, collection 16 in September was a lowpoint at all five river stations as a result of anomalously high flowrates after a period of high rainfall. Seasonal fluctuations of zooplankton density and biomass averaged over the five river stations is given in Figure 21.

Zooplankton numbers and especially biomass decreased from station 6 in the bay to station 1. This is essentially the result of a dilution of the higher biomass, high salinity bay waters by the low biomass freshwater of the river. A number of the dominant and subdominant species were characterized by an inverse relationship between abundance and distance upriver. These include O. colcarva, A. tonsa, polychaete larvae, Pseudodiaptomus coronatus, Oikiopleura dioica, Parvocalanus crassirostris, Euterpina acutifrons, and to a lesser extent, bivalve and gastropod veligers and barnacle nauplii. Species which are bay fauna and show little or no production within the river are characterized by a pattern of strict reduction in density from station to station moving upriver. These include Oithona colcarva and Parvocalanus crassirostris. Some taxonomic groups exhibited abundances not correlated with distance up river at stations of higher salinity and progressively reduced numbers at the upper stations where salinities were very low. These include polychaete larvae, barnacle nauplii and to some extent Saphirella. This is most likely the result of some degree of production or concentration taking place within the river at the higher salinity, lower stations, combined with increasing dilution as at the upper stations.

Most zooplankton groups show an inverse relationship between flow and abundance. For the higher salinity bay fauna, this is most likely the result exclusion from the river by flow. For the freshwater fauna, however, lower densities are probably the result of dilution as rainfall increases river volume at a rate that cannot be compensated for by zooplankton reproduction.

As the river is in a constant state of flux, with salinity regimes moving up and down it in response to rainfall and tides, a spatial community structure is difficult to define. The holoplankton are made up of the bay and true freshwater river fauna with very few species playing an intermediate role (Eurytemora and Halicyclops are in this group). Within the bay fauna, differing abilities to penetrate the lower salinity waters of the river are evident (see Table 5). For example, Acartia, Oithona, Pseudodiaptomus, and Parvocalanus, in that order, show a decreasing penetration into the river.

CONCLUSIONS

The lower section of the Little Manatee that was the focus of this study is a transition zone between the freshwater fauna of the river proper and that of Tampa Bay. Because each station is part of a continuum between very different environments and as this zone actually moves under different flow regimes, it is difficult not only to generalize among stations, but also to compare at a given station among collections. Station was used as the hub of interpretation in this study (as opposed to salinity, for example) because sampling strategies were centered on the stations (equal effort at each station), and because some plankters such as polychaete and bivalve larvae are tied to the benthos and therefore to a stationary area within the river. Averages among the river stations, therefore, are valuable only as an indication of the relative importance of the different groups and say very little about abundance at any one place within the river. An average for different stations in Tampa Bay, for example, is likely to be a more reasonable estimate of abundance at any one spot within the bay than a river average which, depending on the species of concern, is likely to represent merely a dilution of a more concentrated abundance at either the high or low salinity end of the sampling zone. Averages are used only in the interest of briefness, and the graphs of abundance vs. collection give a more realistic interpretation of densities.

Two aspects of the present study are unique among similar investigations made along the west coast of Florida: samples were taken at night and mesh size was considerably smaller than those used previously. The combination of these two factors probably accounts for most of the increase in numbers seen at the bay station as opposed to similar stations in nearby studies (Hopkins 1977, Weiss 1978, Squires 1984). A number of papers describe diel vertical migration for many of the dominant copepods seen in the Little Manatee River (Fulton 1984; Jacobs 1961, 1968; Hamner 1982). With the exception of Oithona and copepod nauplii Fulton (1984) describes all of the dominant copepods in the present study as either bottom oriented or surface avoiding during the day. As Hopkins (1977), Weiss 1978, and Squires (1984) all sampled at the surface during the day their numbers are expected to show lower abundances.

The 28 um mesh employed in this study is considerably smaller than those used by Hopkins (1977), Weiss (1978) and Squires (1984) who used mesh sizes ranging from 64 um to 74 um. Turner (1982) comments on the overwhelming abundance of copepod nauplii taken with a 73 um mesh that was not seen with larger mesh sizes. It is likely that even a 73 um mesh, which is smaller than that used in most zooplankton studies, lets a significant number of nauplii pass through. Hopkins (1977) reports a 31% loss in numbers from a 64 um to a 28 um mesh. As these were mainly copepod nauplii and bivalve larvae, biomass loss was only 6%, but, in cases where copepod nauplii are of interest (e.g., as food for fish larvae) an underestimate caused by too large a mesh size may be significant. Conley and Turner (in review) point out that nauplii may be an important link between the primary production by nanoplankton and larger zooplankton and ichthyoplankton that feed on the nauplii. While it is generally assumed that these athecate nanoplankters are too small to be fed upon by larger zooplankton, copepod nauplii may be able to take advantage of this resource.

The role of zooplankton as food for larval and postlarval fishes in an Newport River estuary, N.C. is addressed by Kjelson and Johnson (1976) who describe the impact of postlarval Lagodon rhomboides and Leiostomus xanthurus on Acartia tonsa. L. rhomboides having a mean weight 25 mg was found to ingest an average of 92 copepods per day, and L. xanthurus having a mean weight of 42 mg, 115 copepods per day. Thayer et al. (1974), also in the Newport estuary, find that larval L. rhomboides and Brevortia tyrannus feed on Acartia, Centropages, Euterpina and Temora, and that the abundance of these zooplankters may be critical to the survival of these fishes during their larval-postlarval transition. Stickney et.al. (1975) investigated the diets of young sciaenids and found copepods to be an important component, especially Pseudodiaptomus coronatus and benthic harpacticoids. Leiostomus xanthurus was found to select for copepods at all growth stages. These studies indicate that planktonic crustacea are important mainly in the diets of larval and postlarval fishes and that juveniles tend to select larger benthic organisms. Mysids were important in the diets of juvenile sciaenids and were mentioned as predators of copepods by Fulton (1984). Mysids may thus serve as a link between zooplankton and bottom feeding fish that are too large to feed on copepods. Gut content studies on the larval, postlarval and juvenile fishes of the Little Manatee River would be the next step in defining the trophic relationship between them and the zooplankton found there.

The accuracy of abundance estimates in this study depend on the assumption that zooplankton densities found in the river channel are representative of those in other areas of the river (i.e., that these are relatively passive organisms that tend to be randomly distributed). There is mounting evidence for both behavioral and physical patchiness for most of the dominant species found in the Little Manatee River. Therefore to truly examine the importance of zooplankton within the river, some smaller scale studies should be made to determine the variation over different habitats found there. For monitoring purposes, however, examination of channel zooplankton only may be adequate. Little long-term monitoring has been done in this area and as the variation in physical parameters and plankton patchiness make data interpretation (i.e., elucidating causal relations between plankton numbers and the physical/biological factors within the river), it would be valuable to continue sampling in the future.

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Table 2. Abundance (number/m^3) by station for year 1. mean; median (range).

	STATION 1 (mile 8.8)	STATION 2 (mile 6.4)	STATION 3 (mile 4.4)	STATION 4 (mile 2.2)	STATION 5 (River Mouth)	STATION 6 (Bay)
HOLOPLANKTON						
Hydromedusae	----	1.62; 0 (0-52)	2.71; 0 (0-52)	4.12; 0 (0-52)	26.6; 0 (0-207)	208; 0 (0-2050)
Cladocera						
Unidentified	60.6; 0 (0-310)	21.0; 0 (0-207)	8.10; 0 (0-103)	8.08; 0 (0-103)	3.25; 0 (0-52)	----
Podon polyphemoides	----	----	----	36.8; 0 (0-1030)	65.5; 0 (0-1240)	550; 0 (0-10300)
Evadne tergestina	----	----	1.08; 0 (0-52)	73.5; 0 (0-2340)	52.6; 0 (0-547)	1490; 0 (0-28400)
Penilia avirostris	----	----	----	45.5; 0 (0-1520)	87.9; 0 (0-2190)	1030; 0 (0-15400)
Copepoda						
Nauplii	23600; 9140 (52-314000)	77000; 43800 (103-316000)	141000; 115000 (258-704000)	158000; 117000 (387-651000)	182000; 157000 (15000-826000)	189000; 133000 (10200-733000)
Calanoida						
Acartia Tonsa	60.1; 0 (0-1100)	2820; 13 (0-36200)	2310; 142 (0-58770)	8030; 654 (0-90800)	11700; 3460 (0-66400)	14000; 9920 (1100-64600)
Eurytemora hirundoides	1480; 672 (0-9300)	688; 142 (0-12800)	359; 0 (0-10500)	64.8; 0 (0-1080)	7.52; 0 (0-206)	2.88; 0 (0-138)
Tortanus setacaudatus	----	----	----	0.542; 0 (0-26)	----	6.10; 0 (0-155)
Parvocalanus crassirostris	----	----	33.0; 0 (0-724)	320; 0 (0-3720)	963; 258 (0-10900)	12000; 6790 (155-70100)
Centropages hamatus	----	----	----	----	----	9.67; 0 (0-464)
Diaptomus spp.	16.6; 0 (0-52)	5.96; 0 (0-310)	7.54; 0 (0-258)	8.60; 0 (0-103)	5.40; 0 (0-129)	----
Pseudodiaptomus coronatus	1.62; 0 (0-52)	10.8; 0 (0-310)	15.1; 0 (0-258)	201; 0 (0-3100)	2010; 284 (0-18600)	3110; 878 (0-22900)

Table 2. (continued) Abundance (number/m^3) by station for year 1. mean; median (range).

	STATION 1 (mile 8.8)	STATION 2 (mile 6.4)	STATION 3 (mile 4.4)	STATION 4 (mile 2.2)	STATION 5 (River Mouth)	STATION 6 (Bay)
Labidocera aestiva	----	----	2.17; 0 (0-52)	----	1.08; 0 (0-52)	94.4; 0 (0-826)
Temora turbinata	----	----	----	----	10.8; 0 (0-207)	79.4; 0 (0-820)
Cyclopoida						
Unidentified Cyclopidae	59.8; 0 (0-362)	22.6; 0 (0-207)	17.2; 0 (0-155)	16.7; 0 (0-207)	8.60; 0 (0-207)	----
Oithona colcarva	1.08; 0 (0-52)	365; 0 (0-3720)	2310; 52 (0-16900)	6710; 513 (0-55900)	33100; 17400 (0-216000)	75600; 51900 (2790-301000)
Oithona nana	0.542; 0 (0-26)	1.44; 0 (0-69)	12.8; 0 (0-276)	24.1; 0 (0-413)	41.8; 0 (0-615)	204; 0 (0-1840)
Oithona simplex	----	1.08; 0 (0-26)	6.46; 0 (0-155)	14.5; 0 (0-413)	55.6; 0 (0-2200)	131; 0 (0-1240)
Halicyclops sp.	45.4; 0 (0-482)	2.71; 0 (0-52)	1.08; 0 (0-52)	4.33; 0 (0-52)	23.2; 0 (0-547)	----
Mesocyclops edax	6.50; 0 (0-104)	----	1.08; 0 (0-26)	2.17; 0 (0-104)	----	----
Saphirella spp.	1.62; 0 (0-52)	61.0; 0 (0-671)	97.6; 0 (0-1030)	146; 13 (0-2320)	422; 129 (0-2790)	1580; 482 (0-8260)
Ergasilidae	20.8; 0 (0-413)	21.0; 0 (0-207)	27.9; 0 (0-207)	23.9; 0 (0-258)	20.3; 0 (0-414)	8.62; 0 (0-207)
Harpacticoida						
Euterpina acutifrons	----	5.76; 0 (0-2760)	7.90; 0 (0-155)	106; 0 (0-1240)	780; 0 (0-16300)	2980; 516 (0-25800)
Miracia sp.	----	0.542; 0 (0-26)	----	----	----	----
Decapoda						
Lucifer faxoni	----	----	----	----	6.46; 0 (0-207)	12.8; 0 (0-410)
Larvacea						
Oikiopleura dioica	----	----	----	457; 0 (0-10700)	1050; 13 (0-15300)	4070; 2000 (0-30700)

Table 2. (continued) Abundance (number/m^3) by station for year 1. mean; median (range).

	STATION 1 (mile 8.8)	STATION 2 (mile 6.4)	STATION 3 (mile 4.4)	STATION 4 (mile 2.2)	STATION 5 (River Mouth)	STATION 6 (Bay)
Chaetognatha						
Unidentified	----	0.542; 0 (0-26)	----	18.3; 0 (0-310)	66.0; 0 (0-1450)	124; 0 (0-1230)
Sagitta hispida	----	----	----	----	15.1; 0 (0-414)	29.9; 0 (0-820)
Sagitta tenuis	----	----	1.62; 0 (0-52)	0.542; 0 (0-26)	44.6; 0 (0-723)	254; 0 (0-2480)
MEROPLANKTON						
Nemertea	5.40; 0 (0-207)	----	----	----	----	----
Polycladida	----	222; 0 (0-5580)	148; 0 (0-6400)	55.4; 0 (1650)	43.7; 0 (0-1140)	170; 0 (0-2460)
Cercaria	----	----	----	0.542; 0 (0-26)	----	----
Annelida						
Oligochaeta	120; 0 (0-826)	23.7; 0 (0-361)	17.2; 0 (0-206)	2.69; 0 (0-77)	0.542; 0 (0-26)	----
Polychaeta	522; 52 (0-8540)	1900; 388 (0-25200)	1880; 1420 (0-9090)	2971; 1420 (0-19100)	4660; 2270 (0-27000)	26100; 7750 (0-393000)
Mollusca						
Gastropod Larvae	18.7; 0 (0-439)	179; 0 (0-1910)	124; 26 (0-1140)	165; 78 (0-1650)	759; 0 (0-7650)	1650; 826 (0-12300)
Pelecypod Larvae	596; 0 (0-11300)	1250; 0 (0-9020)	629; 13 (0-5990)	466; 78 (0-3310)	3800; 542 (0-37500)	7580; 2840 (0-114000)
Cirripedia						
Nauplii	96.7; 0 (0-964)	748; 30 (0-5970)	444; 181 (0-2480)	496; 116 (0-2270)	1940; 413 (0-13400)	2660; 1650 (0-14700)
Cypris	11.5; 0 (0-413)	3.42; 0 (0-138)	5.04; 0 (0-52)	24.8; 0 (0-362)	122; 0 (0-1500)	436; 0 (0-6612)
Stomatopod Larvae	----	----	----	----	----	4.31; 0 (0-207)

Table 2. (continued) Abundance (number/m^3) by station for year 1. mean; median (range).

	STATION 1 (mile 8.8)	STATION 2 (mile 6.4)	STATION 3 (mile 4.4)	STATION 4 (mile 2.2)	STATION 5 (River Mouth)	STATION 6 (Bay)
Decapoda						
Zoea	16.5; 0 (0-275)	57.6; 0 (0-775)	56.7; 0 (0-517)	99.8; 0 (0-1030)	276; 0 (0-4130)	675; 155 (0-4304)
Megalopa	----	1.44; 0 (0-69)	3.06; 0 (0-69)	1.08; 0 (0-26)	36.1; 0 (0-620)	12.8; 0 (0-410)
Mysis-zoea	----	1.62; 0 (0-52)	----	6.48; 0 (0-77)	6.47; 0 (0-103)	32.3; 0 (0-826)
Insecta						
Dipteran Larvae	89.7; 52 (0-361)	41.5; 0 (0-258)	19.1; 0 (0-104)	11.8; 0 (0-155)	----	----
Dipteran Pupae	----	1.08; 0 (0-52)	0.542; 0 (0-26)	----	----	----
Ephimoptera Larvae	3.23; 0 (0-155)	1.08; 0 (0-52)	----	----	----	----
Odonata	4.88; 0 (0-52)	1.62; 0 (0-52)	----	----	----	----
Bipinnaria	----	----	----	----	----	150; 0 (0-3690)
Opheopluteus	----	----	----	----	56.0; 0 (0-2270)	553; 0 (0-6760)
Tornaria	----	----	----	1.08; 0 (0-52)	30.1; 0 (0-930)	390; 0 (0-5780)
Actinotrocha	----	----	----	----	----	8.62; 0 (0-207)
Cyphonauta	----	----	----	2.15; 0 (0-103)	4.83; 0 (0-103)	15.8; 0 (0-413)
Ascidiacea (tadpole larvae)	----	----	----	----	6.46; 0 (0-310)	4.31; 0 (0-207)
Cephlochordata	----	----	----	5.94; 0 (0-103)	327; 0 (0-9300)	623; 0 (0-12300)

Table 2. (continued) Abundance (number/m^3) by station for year 1. mean; median (range).

	STATION 1 (mile 8.8)	STATION 2 (mile 6.4)	STATION 3 (mile 4.4)	STATION 4 (mile 2.2)	STATION 5 (River Mouth)	STATION 6 (Bay)
Pisces Egg	2.88; 0 (0-138)	181; 0 (0-7379)	2.15; 0 (0-103)	31.6; 0 (0-1380)	1610; 0 (0-73800)	314; 0 (0-5990)
Pisces Larvae	4.83; 0 (0-129)	----	3.23; 0 (0-103)	1.62; 0 (0-52)	806; 0 (0-37700)	1880; 0 (0-413)
TYCHOPLANKTON/ HYPOPLANKTON						
Nematoda	54.5; 0 (0-773)	38.2; 0 (0-206)	101; 0 (0-3620)	24.3; 0 (0-104)	78.5; 0 (0-732)	34.8; 0 (0-413)
Hydrazoan colony fragments	----	1.62; 0 (0-52)	----	----	1.08; 0 (0-26)	7.19; 0 (0-207)
Acarina	5.42; 0 (0-52)	2.69; 0 (0-77)	363; 0 (0-17110)	1.08; 0 (0-52)	----	9.33; 0 (0-207)
Ostracoda	139; 52 (0-689)	77.4; 26 (0-516)	8.6; 0 (0-465)	23.2; 0 (0-775)	36.2; 0 (0-723)	225; 0 (0-2460)
Harpactacoida (benthic)						
Unidentifed	1200; 310 (0-12300)	4060; 904 (0-55300)	5440; 736 (0-129000)	1090; 774 (0-4180)	889; 671 (0-4650)	909; 414 (0-5320)
<u>Parategasres</u> <u>spericus</u>	----	----	2.15; 0 (0-103)	8.27; 0 (0-138)	22.6; 0 (0-412)	12.8; 0 (0-410)
<u>Metis</u> spp.	----	----	----	1.08; 0 (0-52)	----	8.62; 0 (0-207)
Isopoda	3.23; 0 (0-77)	16.7; 0 (0-517)	7356; 0 (0-103)	15.3; 0 (0-207)	69.5; 0 (0-547)	77.3; 0 (0-820)
Amphipoda	74.4; 0 (0-826)	154; 0 (0-2070)	139; 0 (0-4490)	17.5; 0 (0-207)	21.2; 0 (0-310)	12.6; 0 (0-207)
Cumacea	----	2.88; 0 (0-69)	----	5.94; 0 (0-103)	27.2; 0 (0-275)	4.85; 0 (0-103)
Mysidacea	17.8; 0 (0-517)	15.1; 0 (0-206)	18.3; 0 (0-362)	27.1; 0 (0-310)	105; 0 (0-1640)	58.8; 0 (0-1230)
Tardigrada	1.62; 0 (0-26)	3.23; 0 (0-155)	----	----	----	----

Table 5. Uncommon (<0.1% total numbers) species seasonal distribution. 24 samplings broken into 12 monthly sets of 2 collections each. 1-6 indicates stations where present. * >100 percubic meter, ** >500 per cubic meter.

	1	2	3	4	5	6	7	8	9	10	11	12
HOLOPLANKTON												
Hydromedusae		6*	3-6	5	56*	26**	36		6**	3*5*6	46	456
Unidentified Cladocera	12	1*2*34	12345				145	23	1*23	1*	1*23	
<u>Podon</u> <u>polyphemoides</u>	456*	56**	56*	46*							45	4*5** 6**
<u>Evadne</u> <u>tergestina</u>				34** 5*6**	45*6**	56					56*	56*
<u>Penilia</u> <u>avirostris</u>				4**5** 6**	456**	6**						
<u>Tortanus</u> <u>setacaudatus</u>	46	6										
<u>Centropages</u> <u>hamatus</u>		6*										
<u>Diaptomus</u> spp.			1-4	1	15		1245	1-5	1	1	1-3	
<u>Labidocera</u> <u>aestiva</u>				6*	36*	56	6*	6*	6	6		
<u>Temora</u> <u>turbinata</u>					56*	6**			6	6*	5	6
Unidentified Cyclopidae		1-4	1*23		2	1	1245	1*-5	1-4	125	1*-3	13
<u>Oithona</u> <u>nana</u>				23*4*	46*	45*6**	56**	45	56*	46*	456*	35
<u>Oithona</u> <u>simplex</u>				4*5**6	346*	2-4	56*	4	6**	6*	2456*	6
<u>Oithona</u> <u>plumifera</u>						6*	6					
<u>Halicyclops</u> sp.				1*5*	15	5	1*	12	3-5	1245	1	145

Table 5. Uncommon (<0.1% total numbers) species seasonal distribution. 24 samplings broken into 12 monthly sets of 2 collections each. 1-6 indicates stations where present. * >100 percubic meter, ** >500 per cubic meter.

	1	2	3	4	5	6	7	8	9	10	11	12
Mesocyclops edax								14	3	1		
Ergasilidae			3-5	12* 34*	1-5	12*34	345*	5	34	1-46	234	236
Miracia sp.												2
Lucifer faxoni					5	6*	5					
Unidentified Chaetognatha	2		5		46*	56*	6*		56*	45*6*	45*6*	4*5*6*
Sagitta hispida					5*6*	56*						
Sagitta tenuis					5	3456**	5*6**	6**	56*	35*6*		56*
MEROPLANKTON												
Nemertea				1	1							
Polycladida												
Cercaria												4
Oligochaeta	2	1	1*235	1	2		13*4	1*234	1*2*	1	123	13
Cypris Larvae	23	3		1*25*6*	6	356*	34*5*	56*	345*6**	345*6*	4*5*6**	46*
Stomatopod Larvae							6					
Zoea	56*	56	2-5	1**23** 4*5**6**	1*23* 4*5*6**	1**2*3* 4*5**6**	2356*	234 56**	234 56*	1234 56**	4	2
Megalopa			6	235	5*6*	3456	5		45			

Table 5. Uncommon (<0.1% total numbers) species seasonal distribution. 24 samplings broken into 12 monthly sets of 2 collections each. 1-6 indicates stations where present. * >100 percubic meter, ** >500 per cubic meter.

	1	2	3	4	5	6	7	8	9	10	11	12
Mysis-zoea						245	46*	456	456			6
Dipteran Larvae	123	1234	1234	123	12	1	1*2*34	1234	1*2	1*2	1*23	1
Dipteran Pupae			23									
Ephimoptera Larvae							12					
Odonata							12	1			12	1
Bipinnaria					6**	6*	6*		6			6
Opheopluteus					6**	6**	6**	6*	6		5**6**	
Tornaria					6**	6**	6*			6	45*6**	
Actinotrocha							6		6			
Cyphonauta										56		45
Ascidiacea (tadpole larvae)		6				5						
Cephlochordata				5*6**	5**6**	6**					56	
Pisces Egg	256*	6**	6**	12**3 4*5*6**	5**	6*	2	6			6*	
Pisces Larvae			56	5**6	346*	6	6*	1456	5			
TYCHOPLANKTON/ HYPOPLANKTON Nematoda	12345	1234 5*6*	123 456	135*	15	12	123 45	1*23 45	123 456	1*345	123 46	123 45*

Table 5. Uncommon (<0.1% total numbers) species seasonal distribution. 24 samplings broken into 12 monthly sets of 2 collections each. 1-6 indicates stations where present. * >100 percubic meter, ** >500 per cubic meter.

	1	2	3	4	5	6	7	8	9	10	11	12
Hydrazoan colony fragments	5	6	2						6		2	
Acarina	12	13	136	13	4				1236		13	1
Ostracoda	1*256	1*2*3 4*56*	12*3* 45*6*	1*2*3 56**	1*2*3 56*	1*3 56*	1*2*34	1235	14	12	125	1*23 45*6*
<u>Parategastes</u> <u>sphericus</u>				45*	356*	45	5	8		45		4-6
<u>Metis</u> spp.					4		6	6				
Isopoda	356	56	45	45*6	234 56*	356*	2356	1356	123 456	134 56*	45	45*6
Amphipoda	36	5	2356	1*2*4	1*2** 35	1*24 56*	12** 3**4	14	45	4	2345	245
Cumacea	56		6	25	45	45		5			5	456
Mysidacea	123 456	45	2346	4*5*6	123 45*6*	1*23 456	345*	5	3	46*	1	1235
Polycladida	45*6*	56*	56	2*3 4*6**	2**3** 4**6*	25	6*	6	6	46*	6	56*
Tardigrada							1	12	1			

Table 6. Plankton category abundance (number/m^3) and Biomass (mg/m^3; in parentheses) averaged throughout the year by station.

PLANKTON TYPE	STATION 1 (mile 8.8)	STATION 2 (mile 6.4)	STATION 3 (mile 4.4)	STATION 4 (mile 2.2)	STATION 5 (river mouth)	STATION 6 (bay)
HOLOPLANKTON	29600 (5.69)	84100 (15.1)	150000 (34.3)	175000 (42.8)	232000 (88.4)	308000 (149.0)
MEROPLANKTON	1490 (1.03)	4400 (3.55)	3190 (1.66)	4280 (2.86)	14500 (5.68)	41400 (22.6)
TYCHO/HYPOPLANKTON	1560 (3.09)	4620 (12.7)	6210 (11.3)	1300 (2.54)	1310 (3.45)	1540 (3.69)

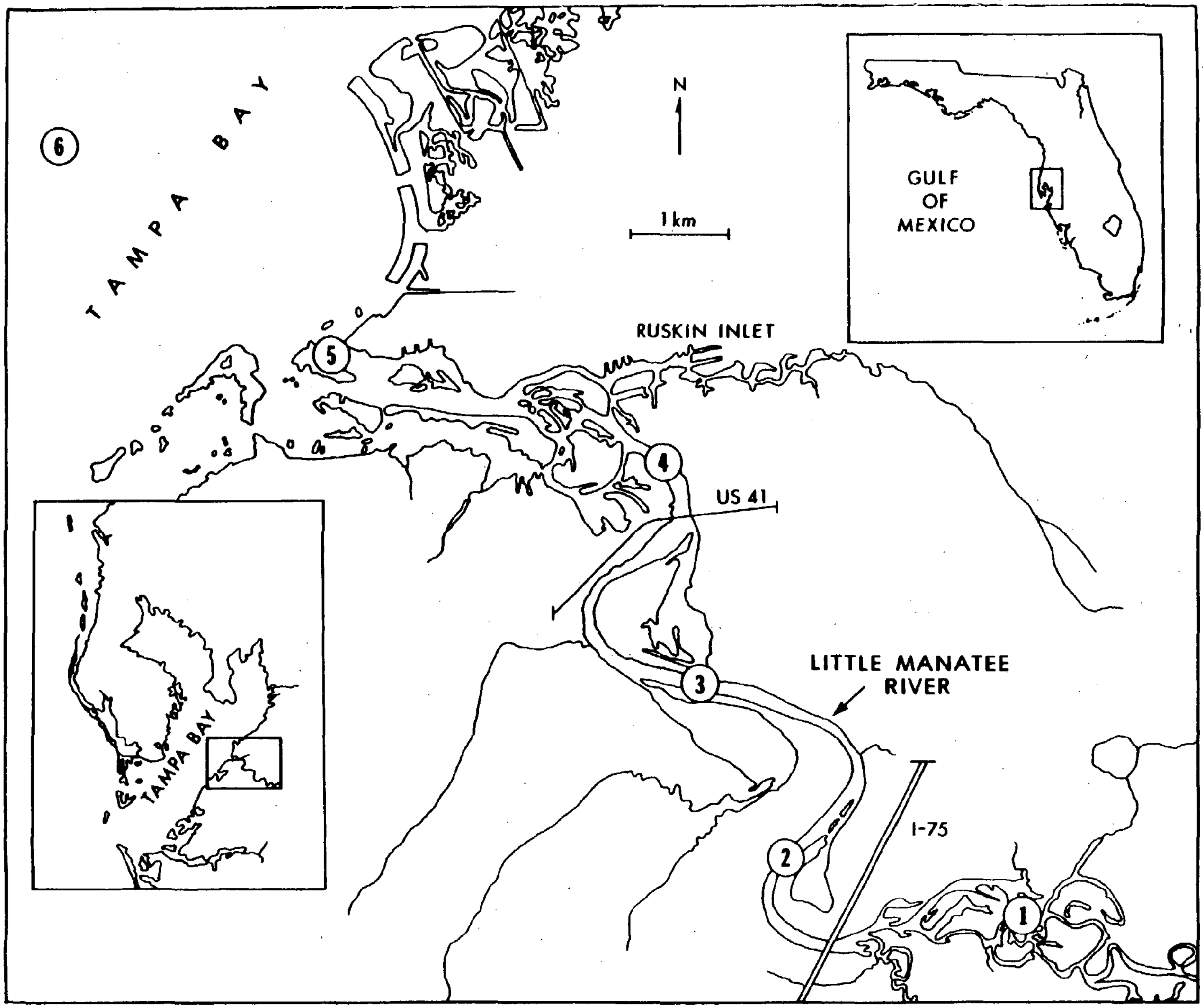

Fig. 1a. Map of Little Manatee River showing station locations.

Fig. 1. Salinity.

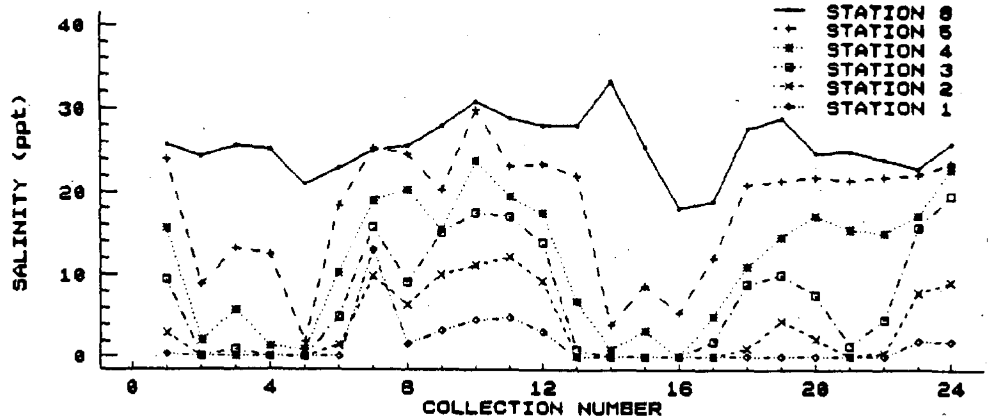

Fig. 2. Temperature.

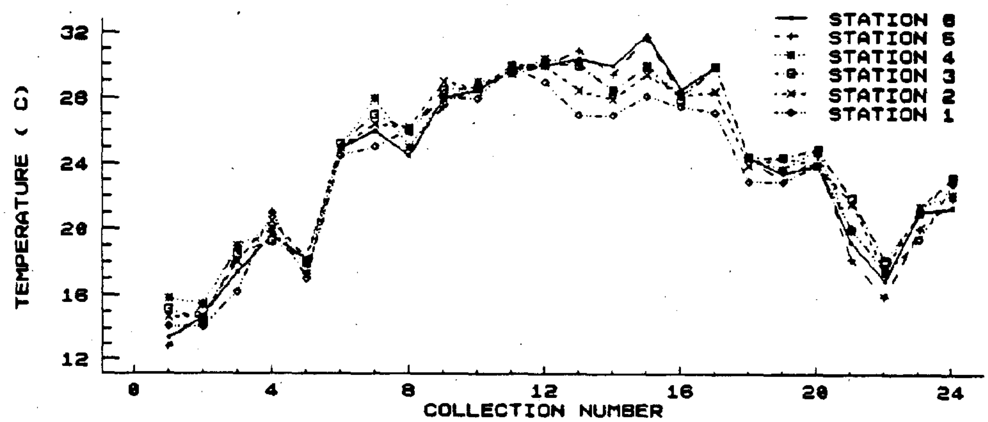

Fig. 3. Dissolved Oxygen.

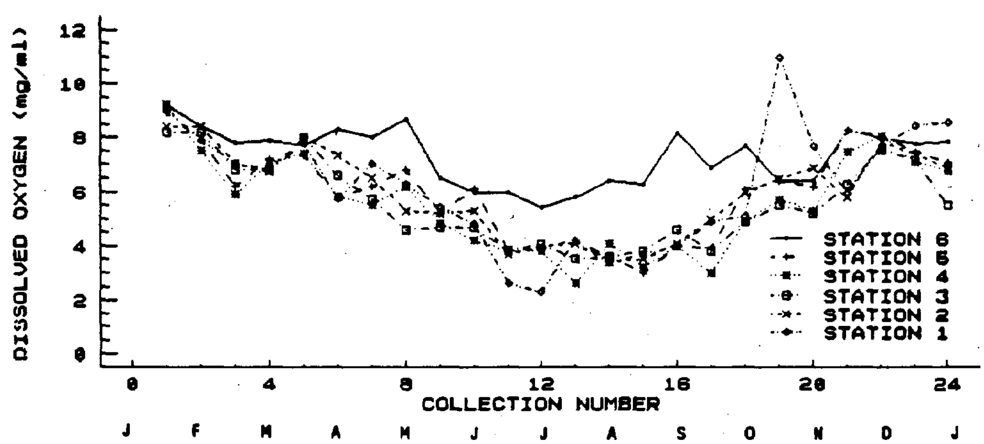

Fig. 4. Flow in the Little Manatee River during sampling. Readings taken near Wimauma.

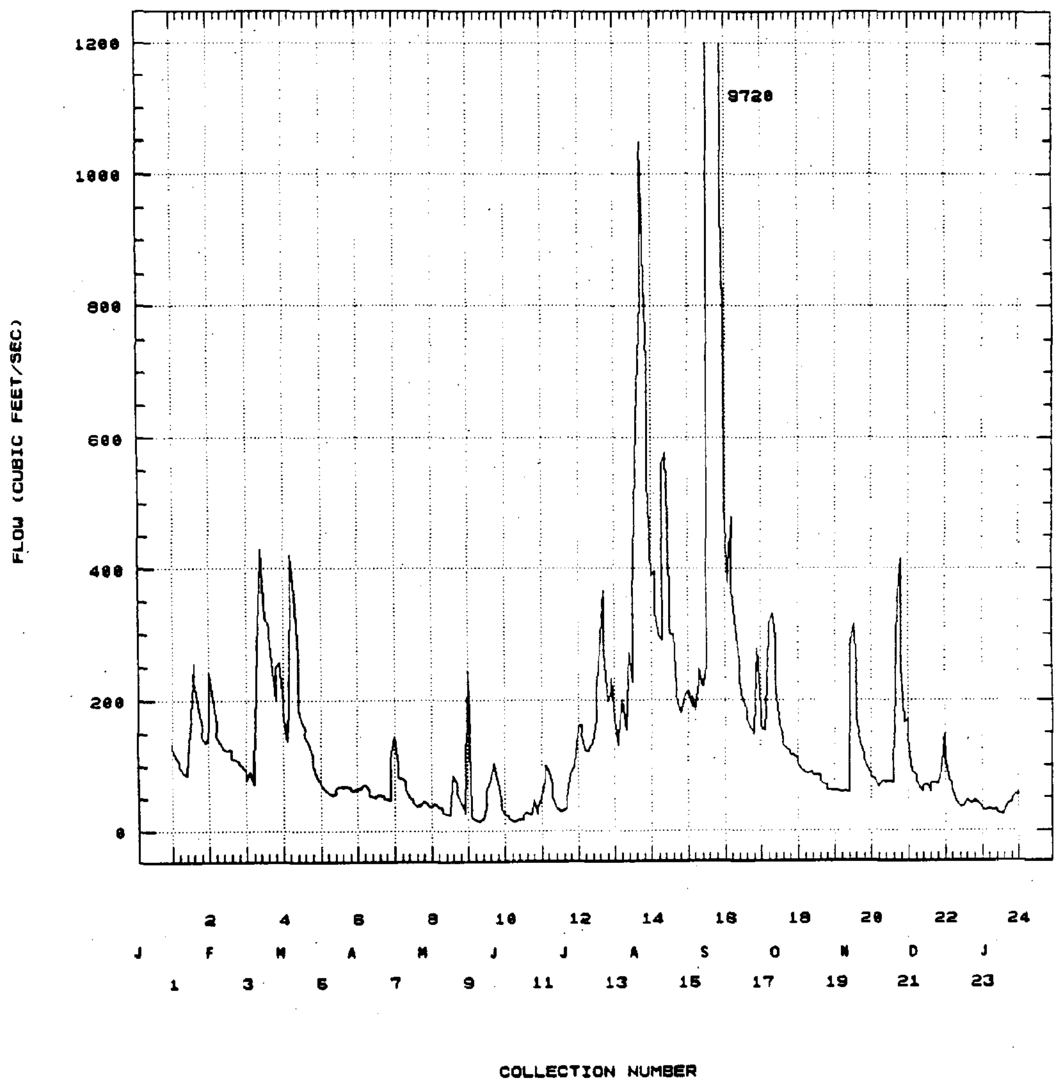

Fig. 5. Copepod nauplii densities.

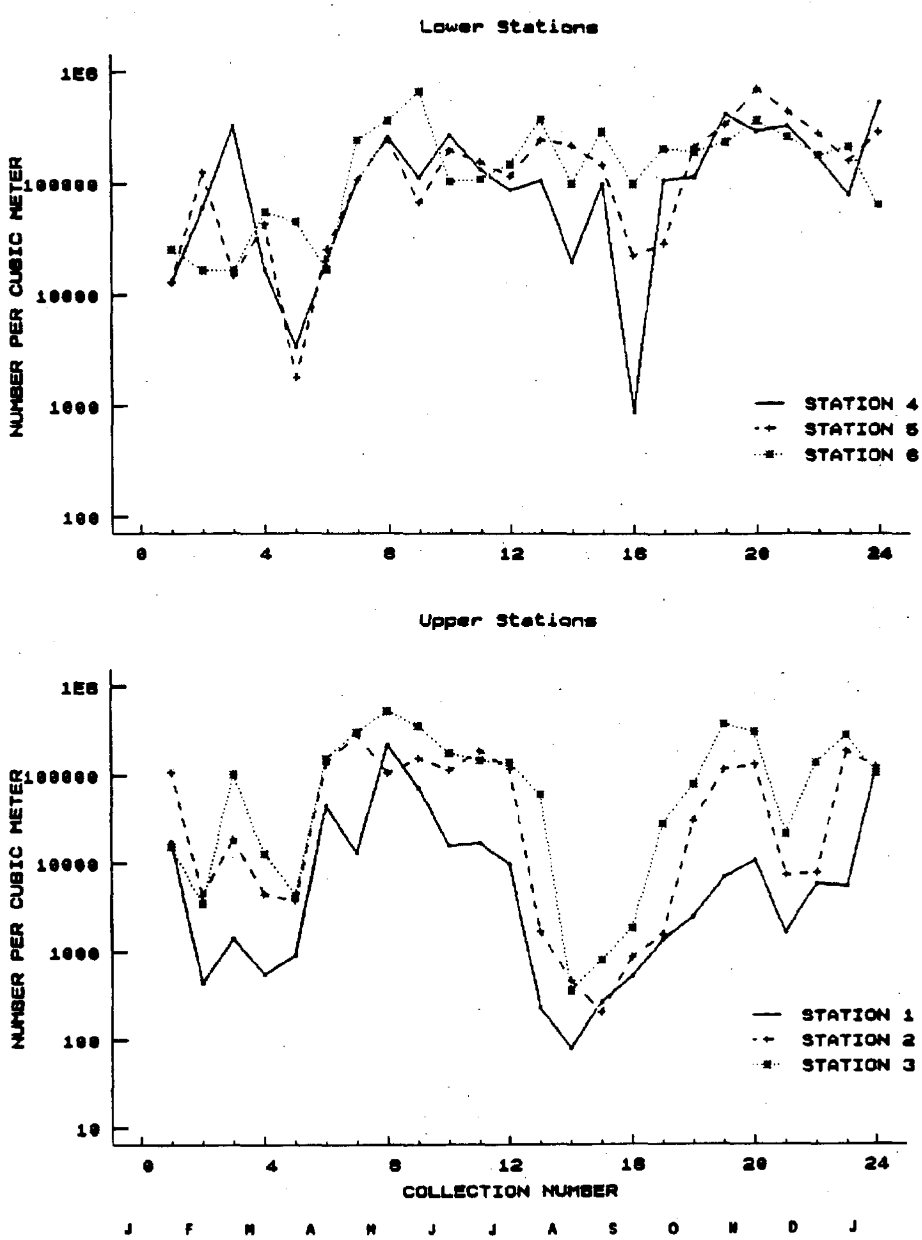

Fig. 6. Oithona colcarva densities.

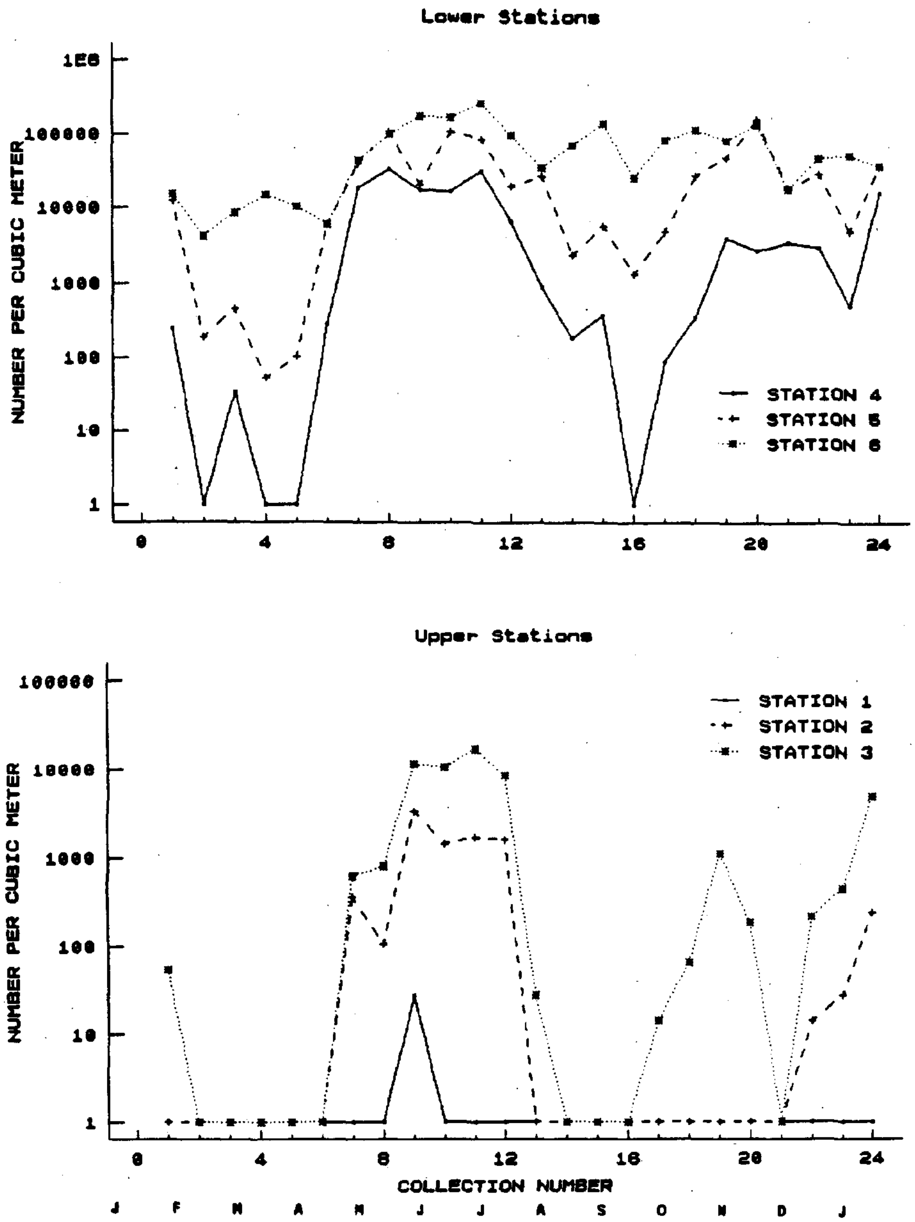

Fig. 7. Acartia tonsa densities.

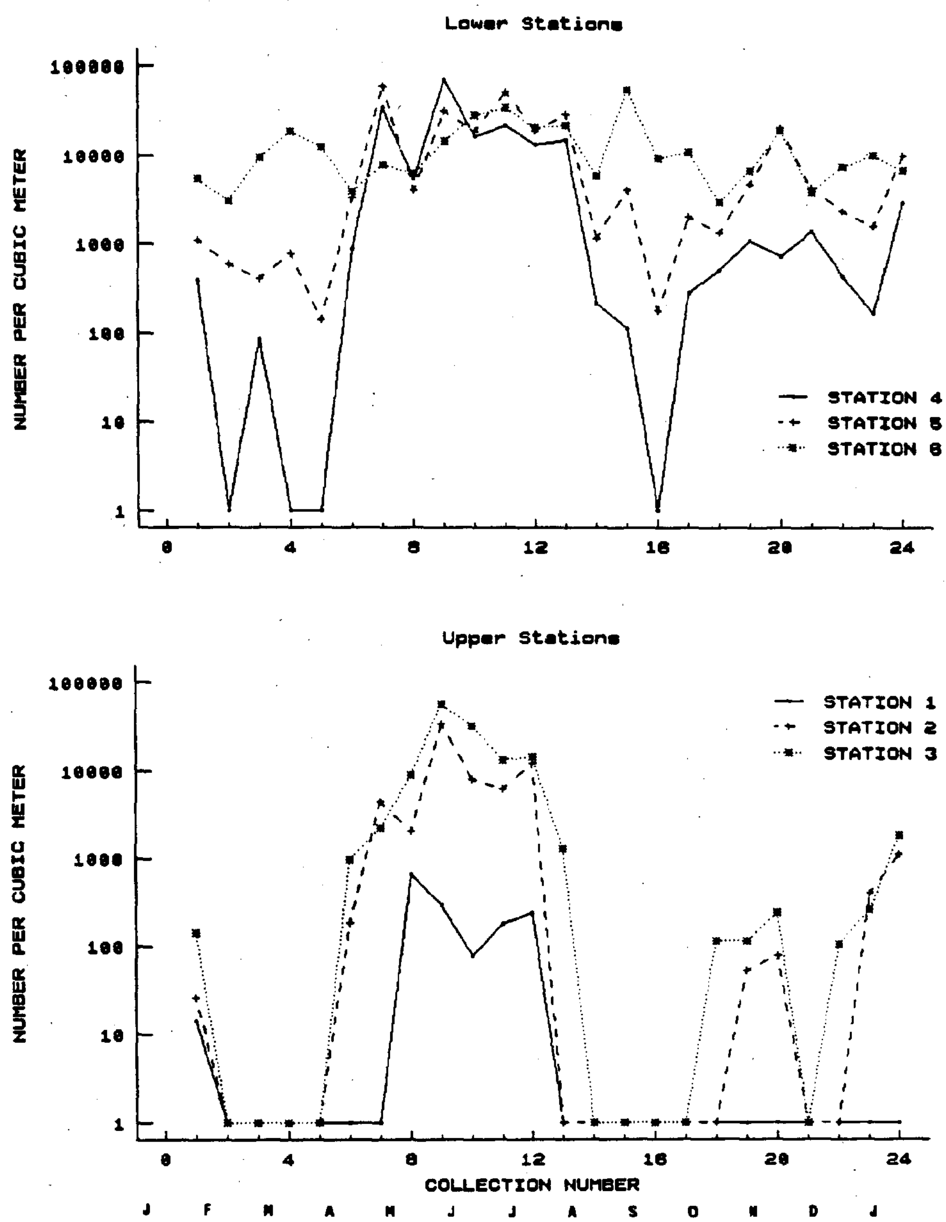

Fig. 8. Benthic harpacticoid copepod densities.

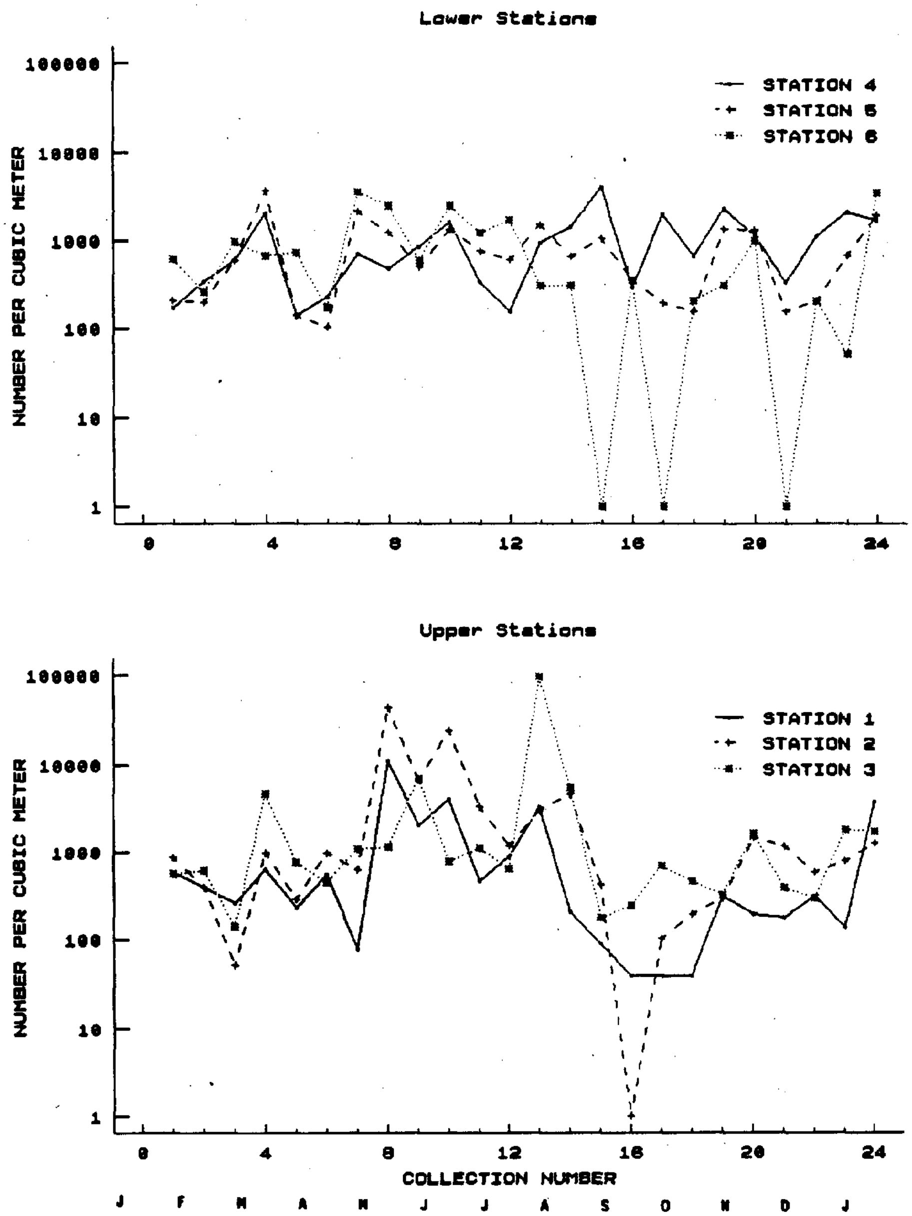

Fig. 9. Rotifer densities.

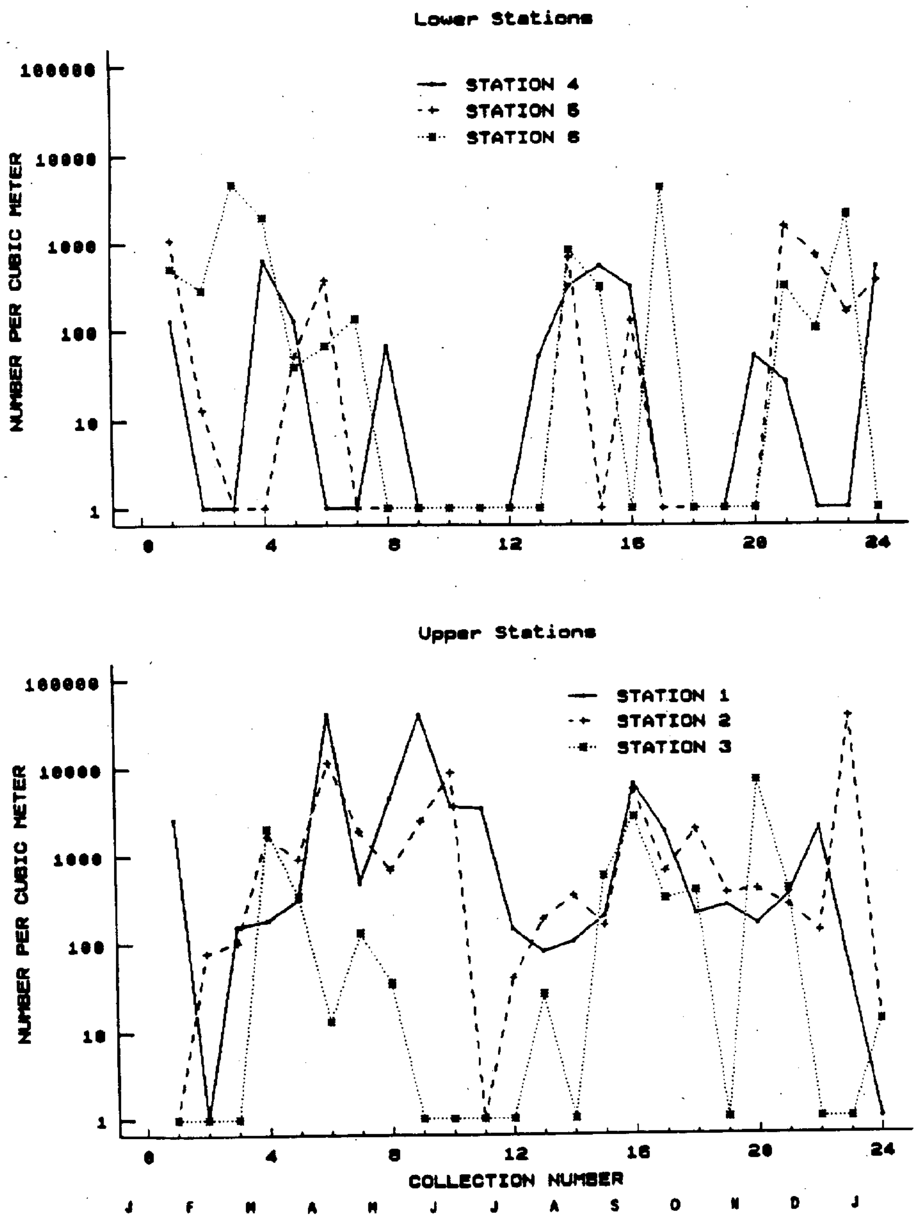

Fig. 10. Polychaete larvae densities.

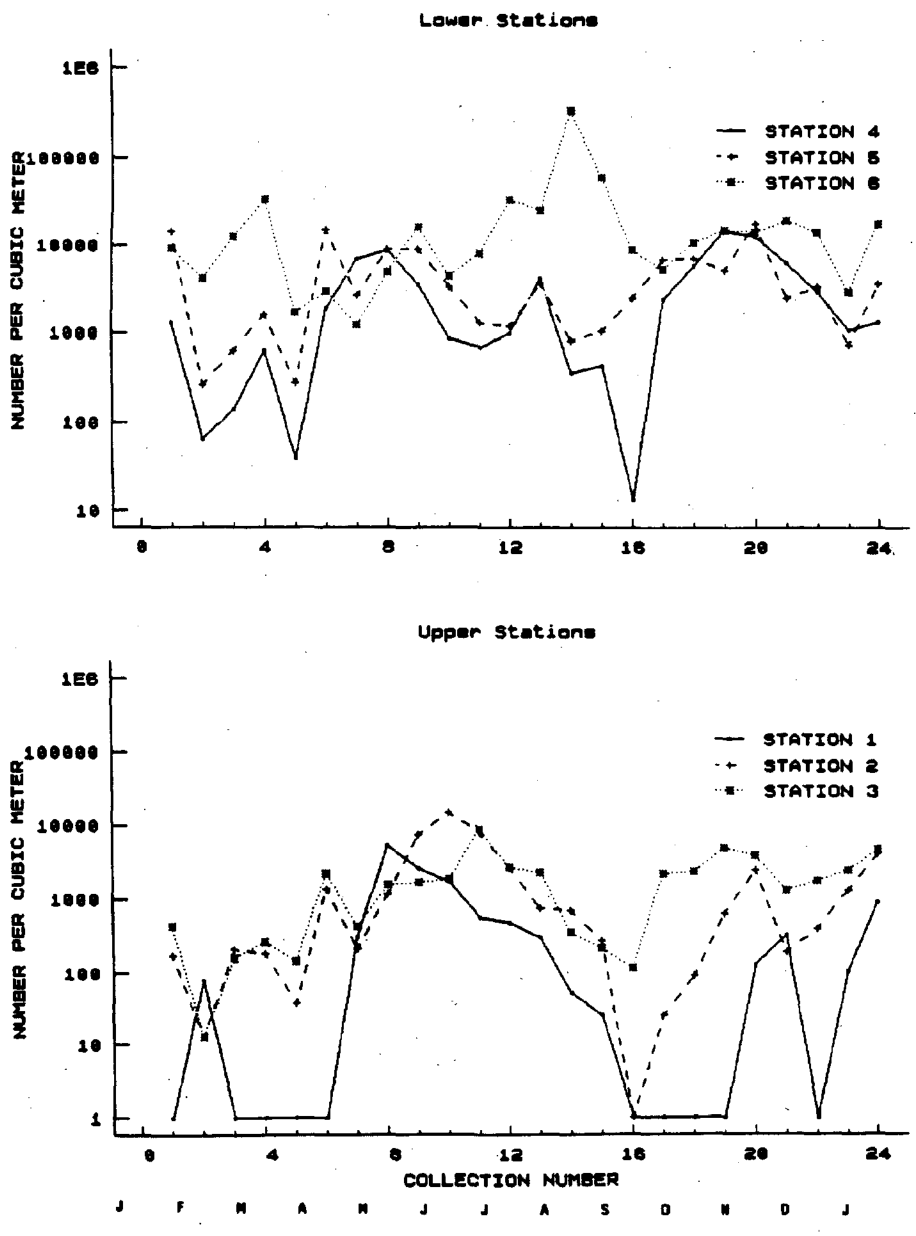

Fig. 11. _Pseudodiaptomus_ _coronatus_ densities.

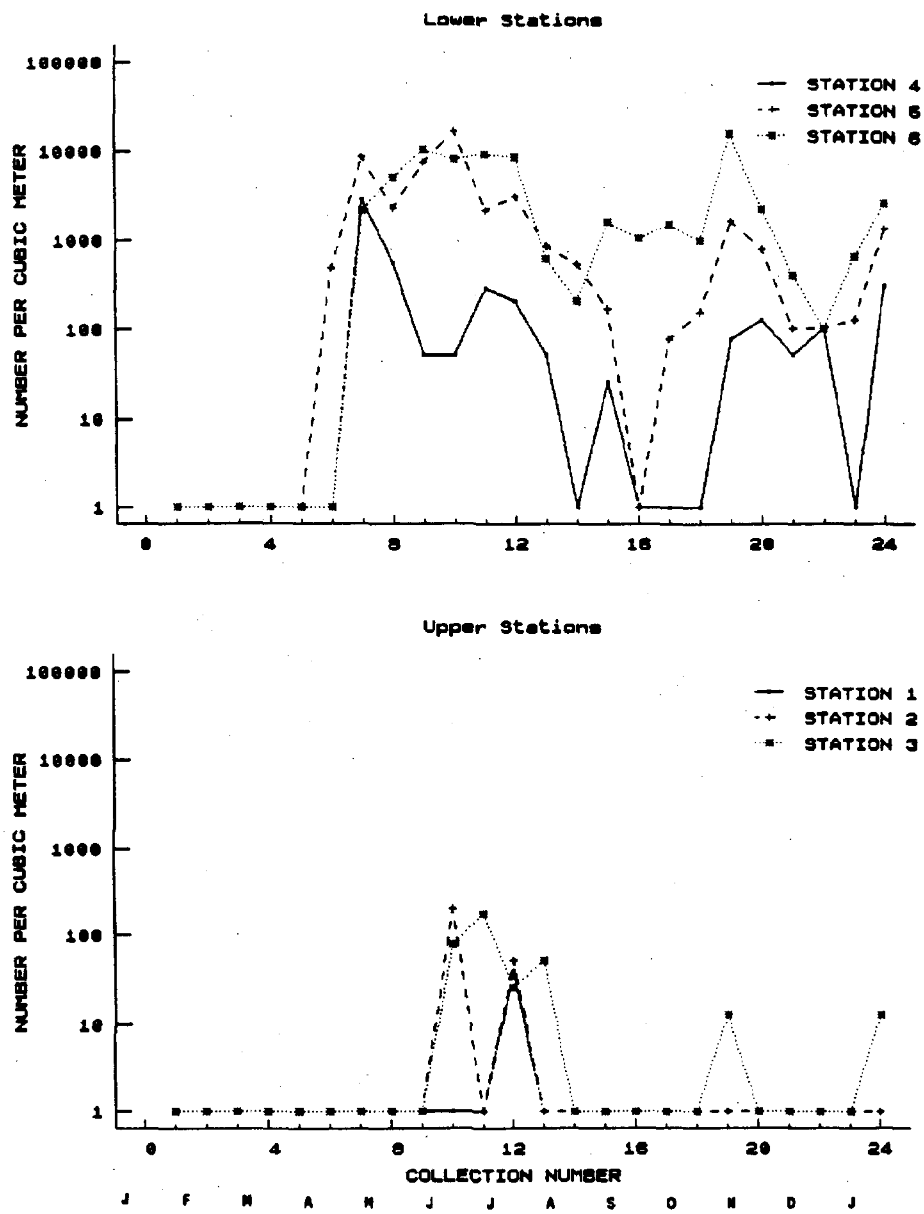

Fig. 12. Parvocalanus crassirostris densities.

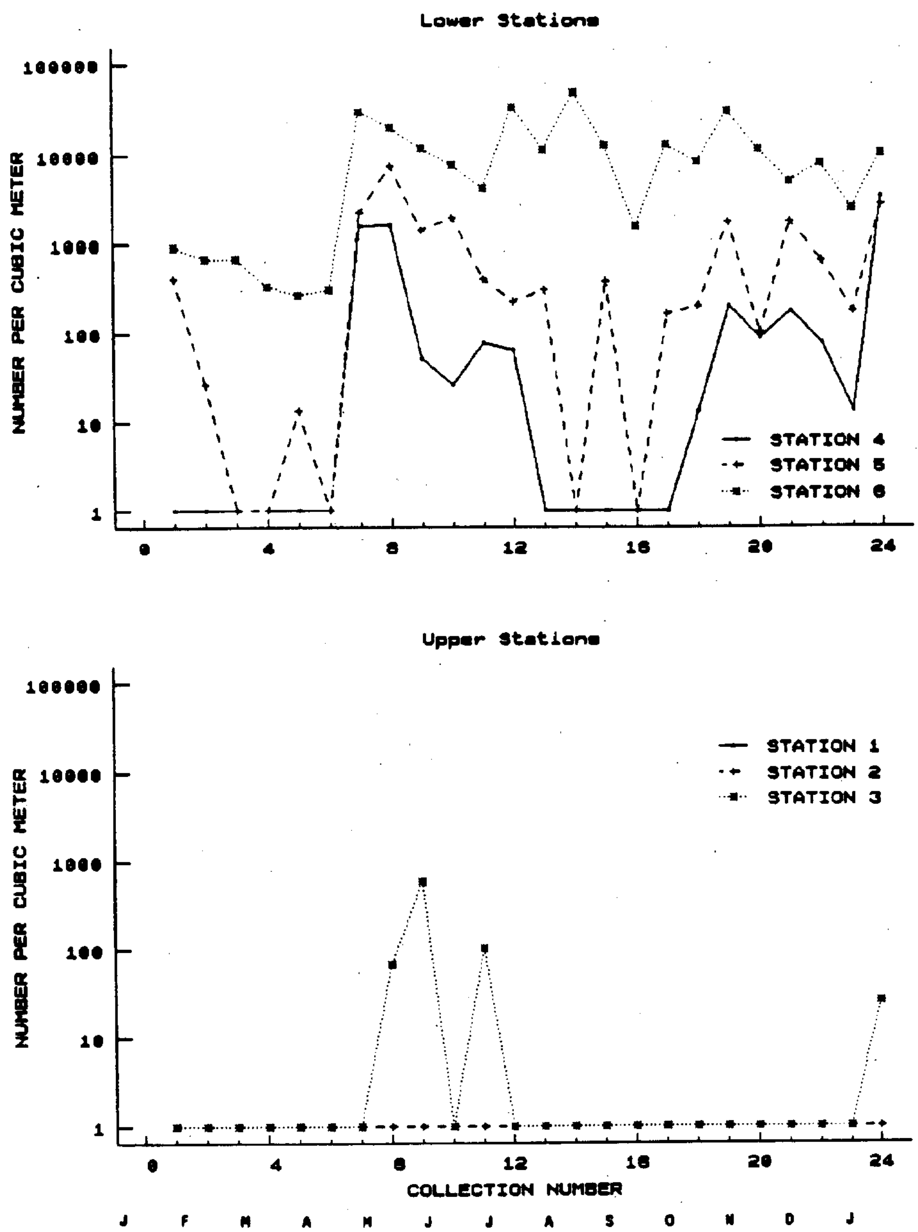

Fig. 13. Euterpina acutifrons densities.

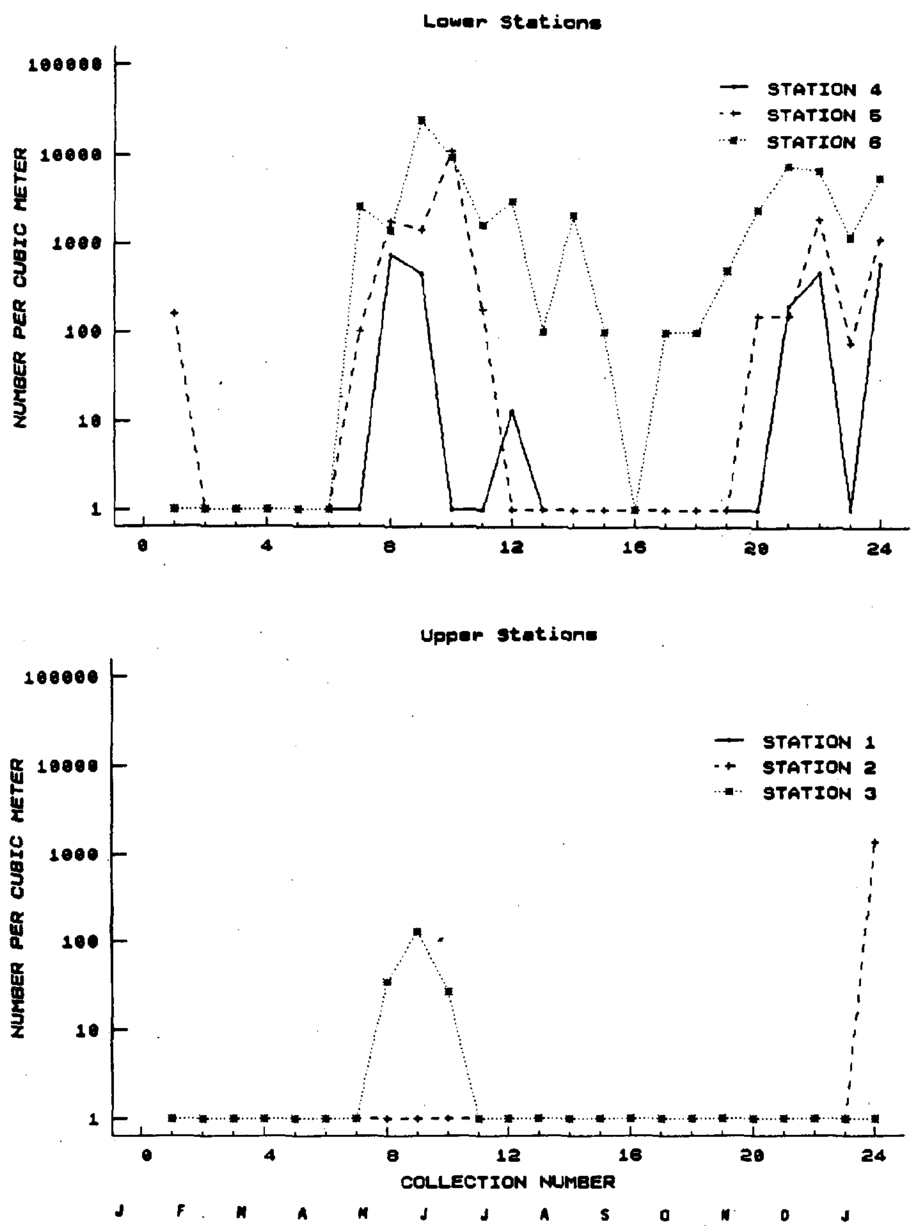

Fig. 14. Oikipleura dioica densities.

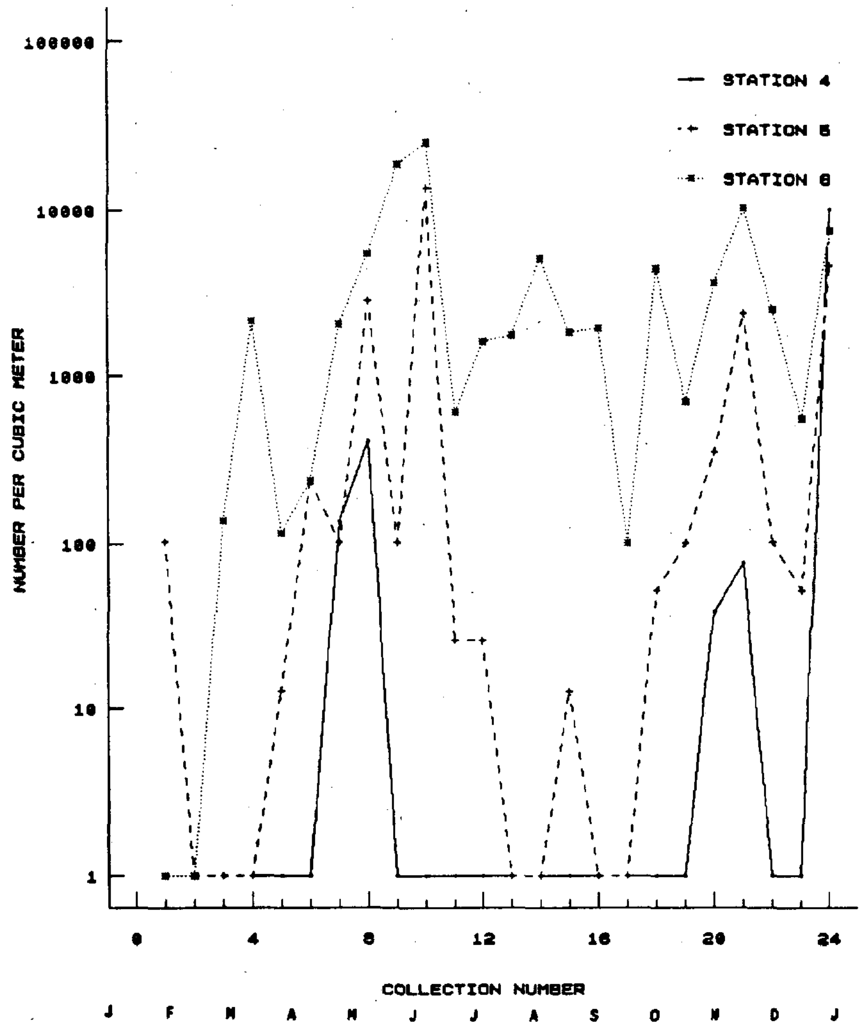

Fig. 15. Saphirella spp. densities.

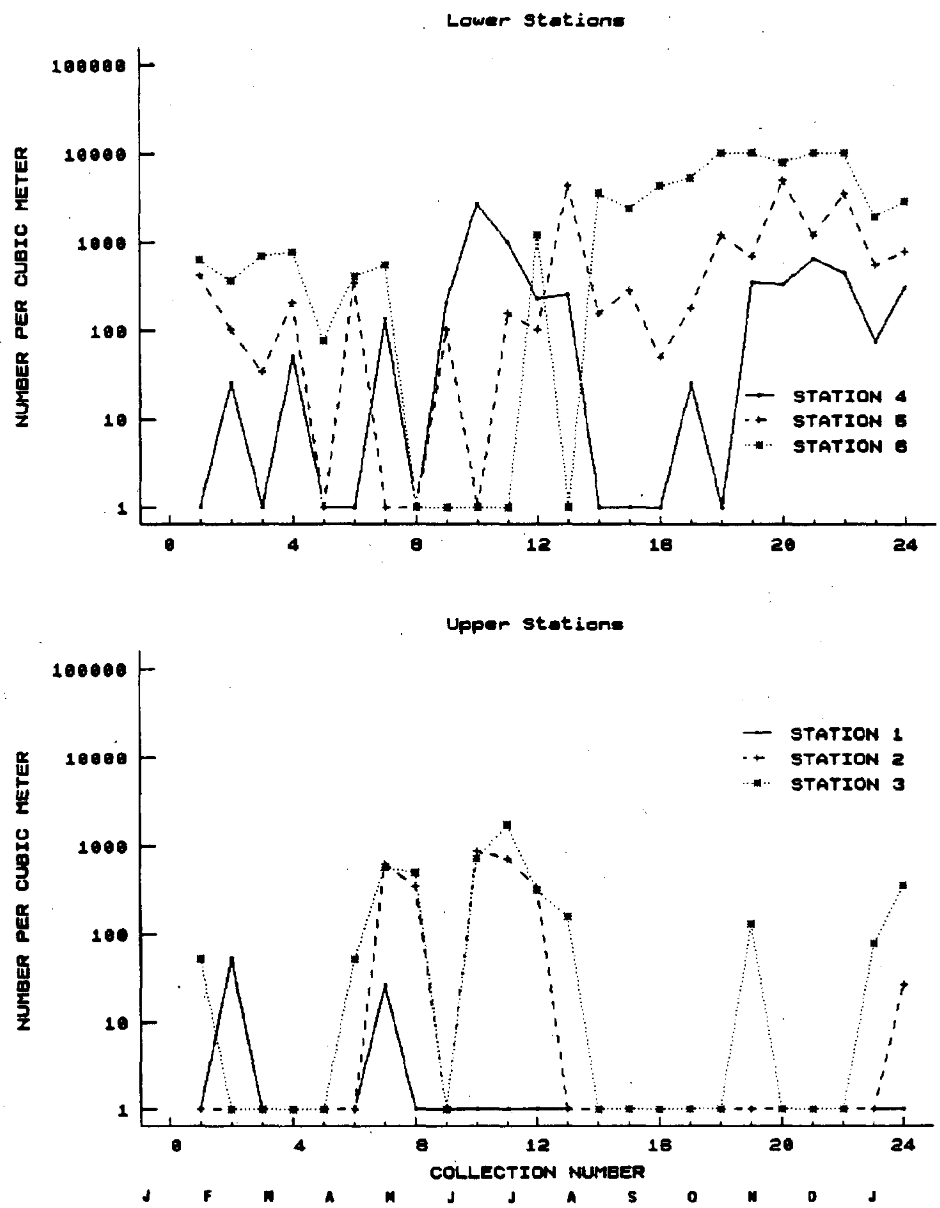

Fig. 16. Eurytemora hirundoides densities.

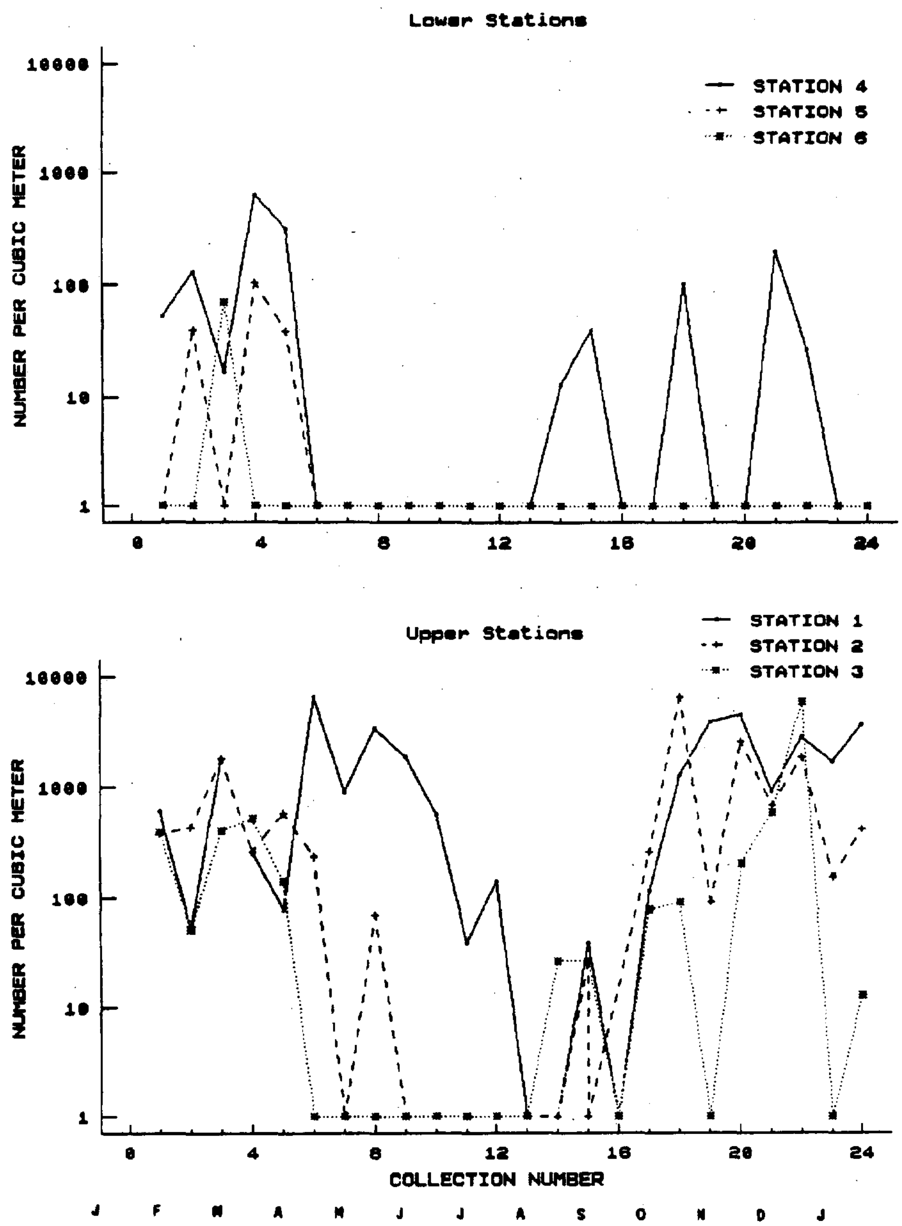

Fig. 17. Bivalve larvae densities.

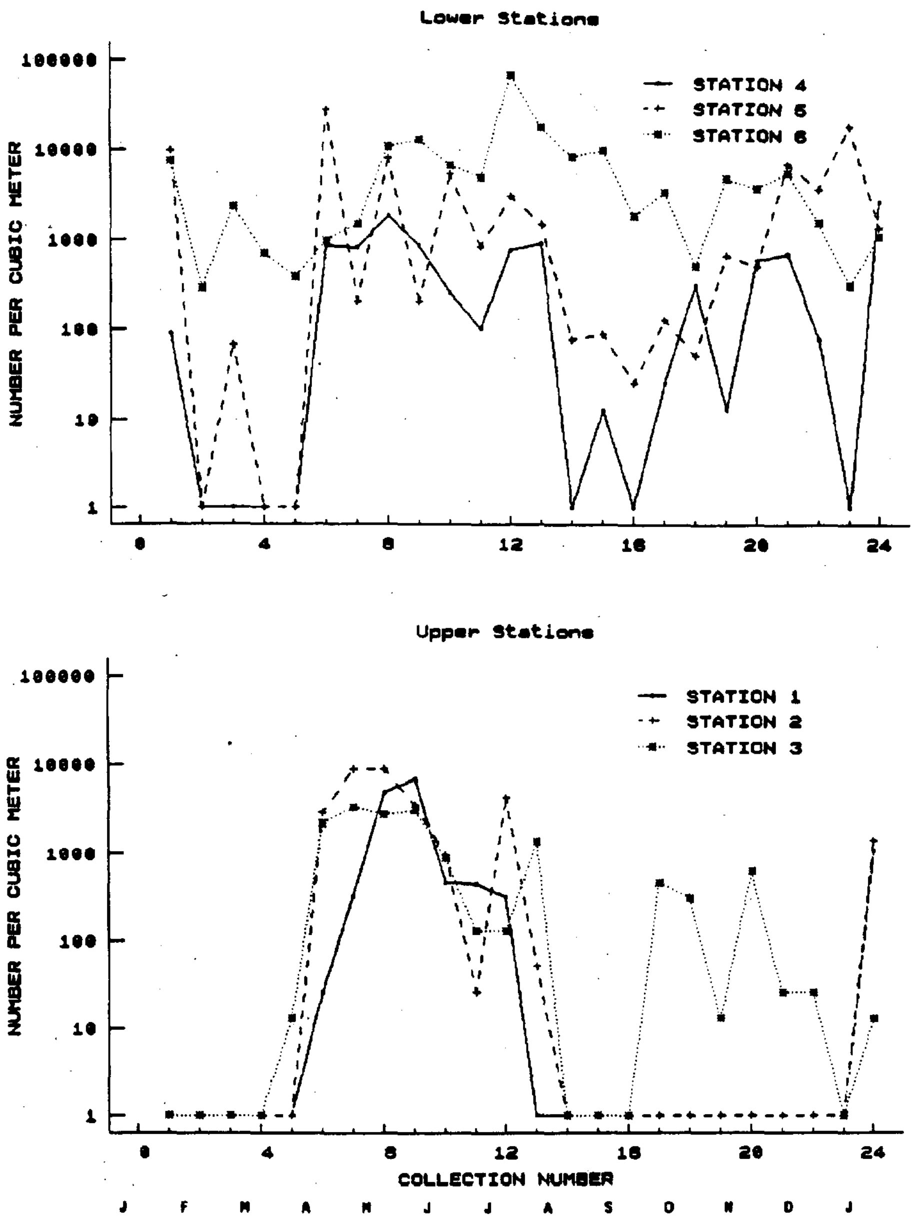

Fig. 18. Gastropod larvae densities.

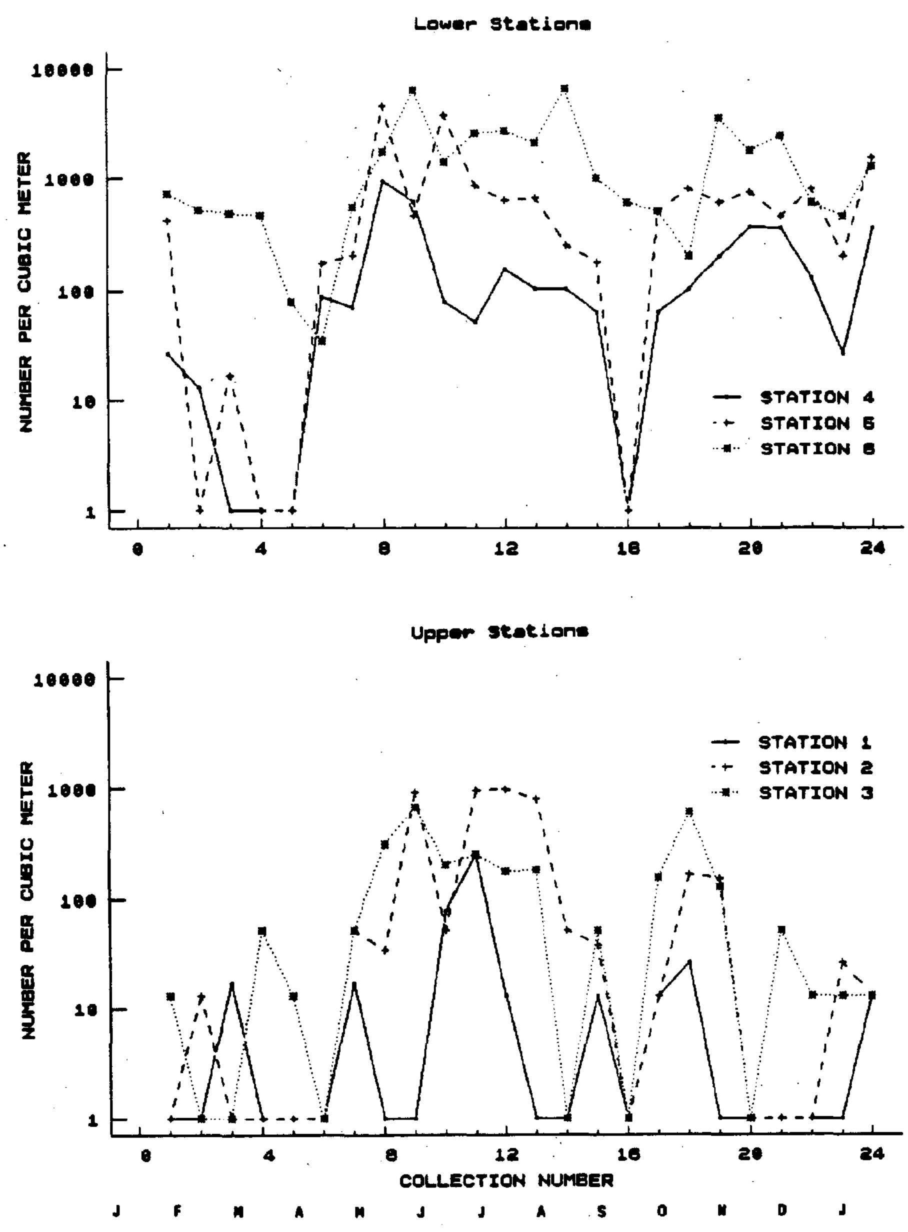

Fig. 19. Barnacle nauplii densities.

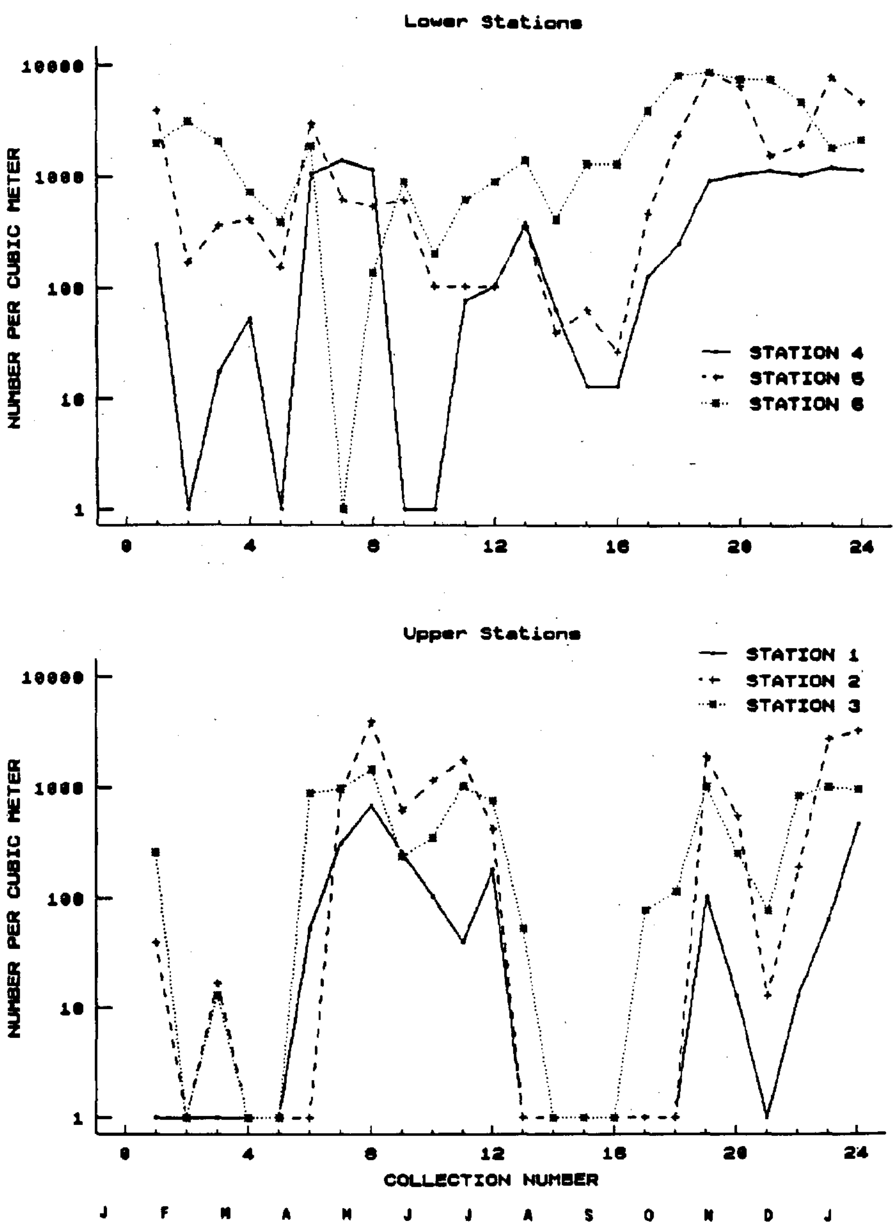

Fig. 20. Zooplankton abundance and Biomass by station.

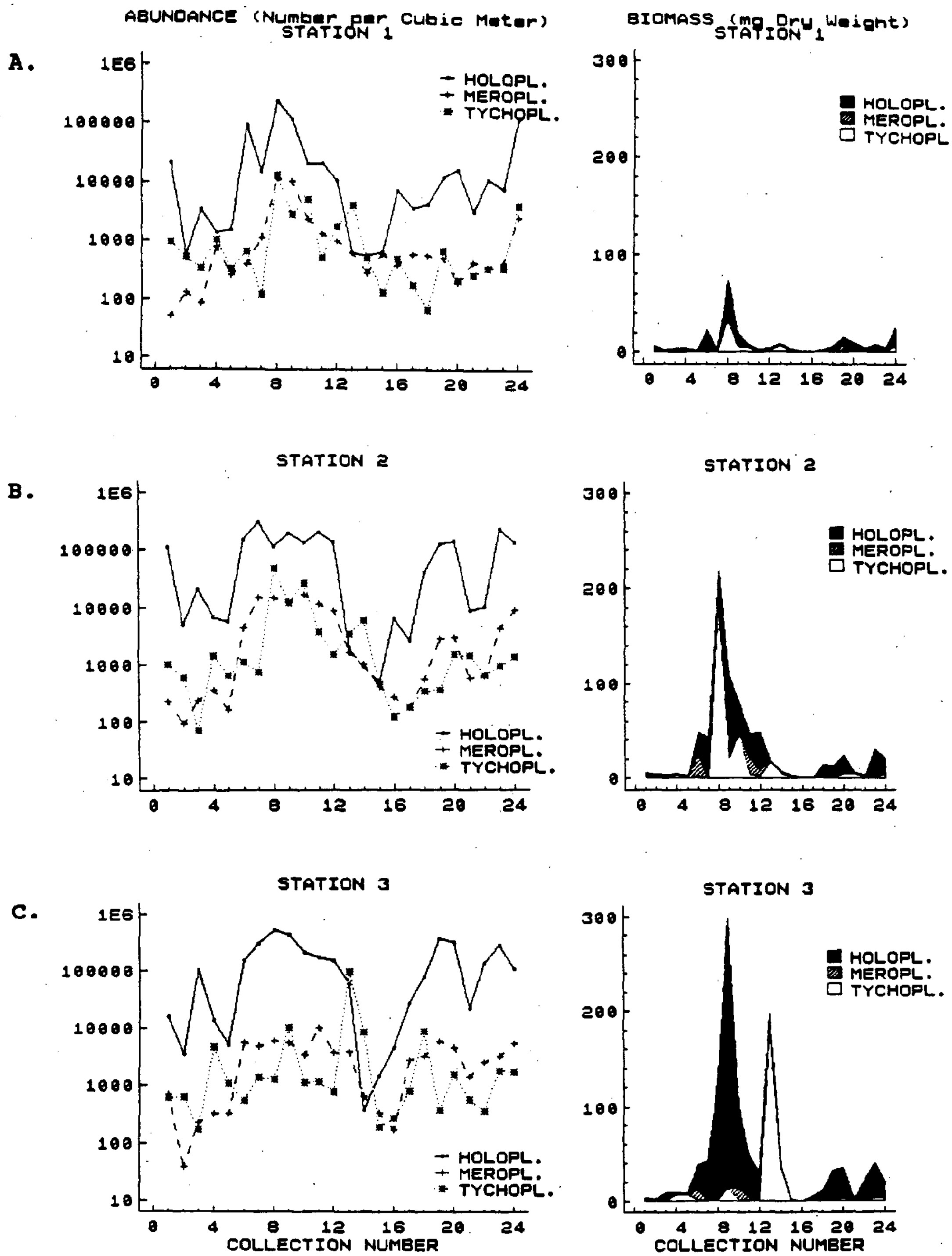

Fig. 20. Zooplankton abundance and Biomass by station.

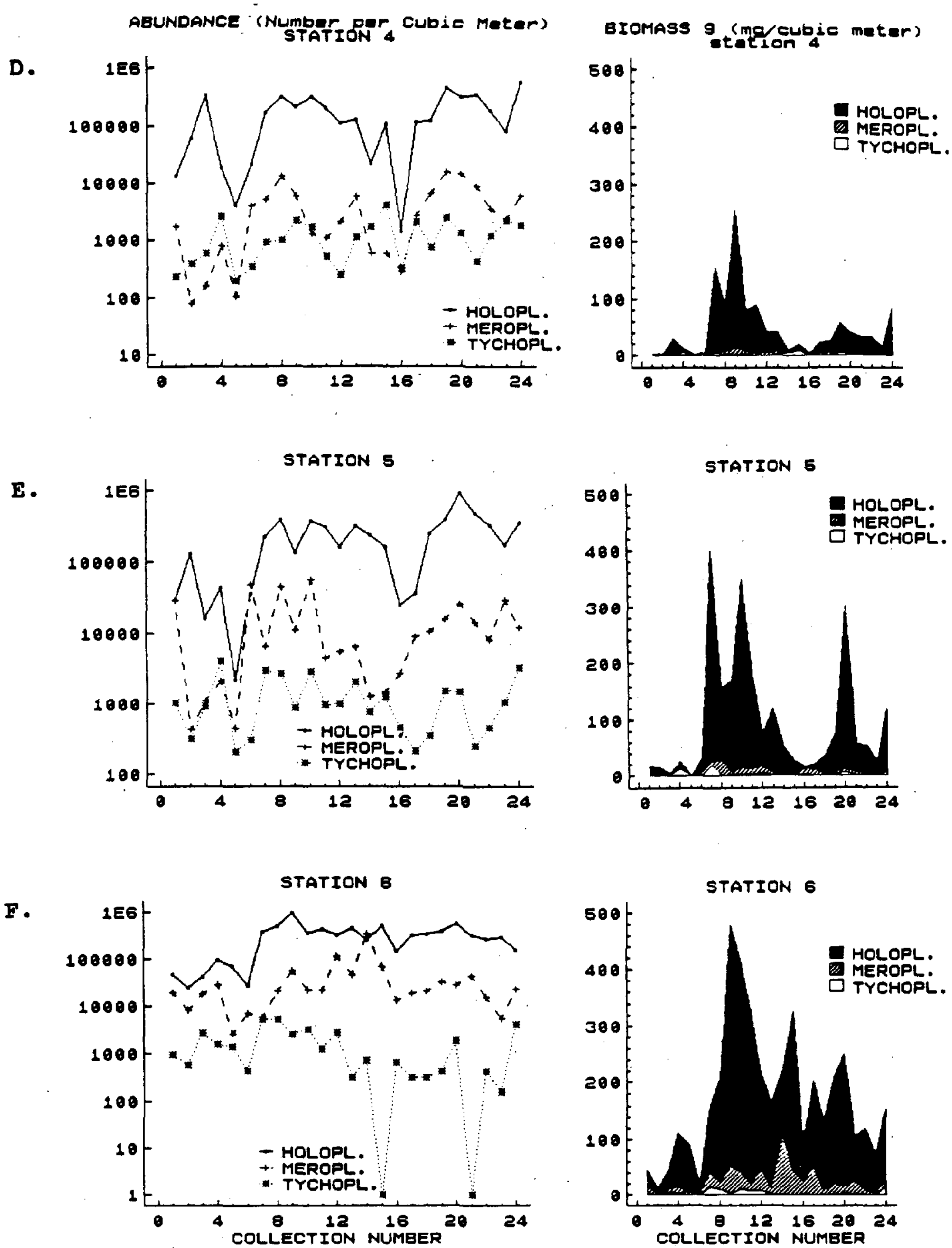

Fig. 21. Total zooplankton abundance and biomass averaged for the river (stations 1-5).